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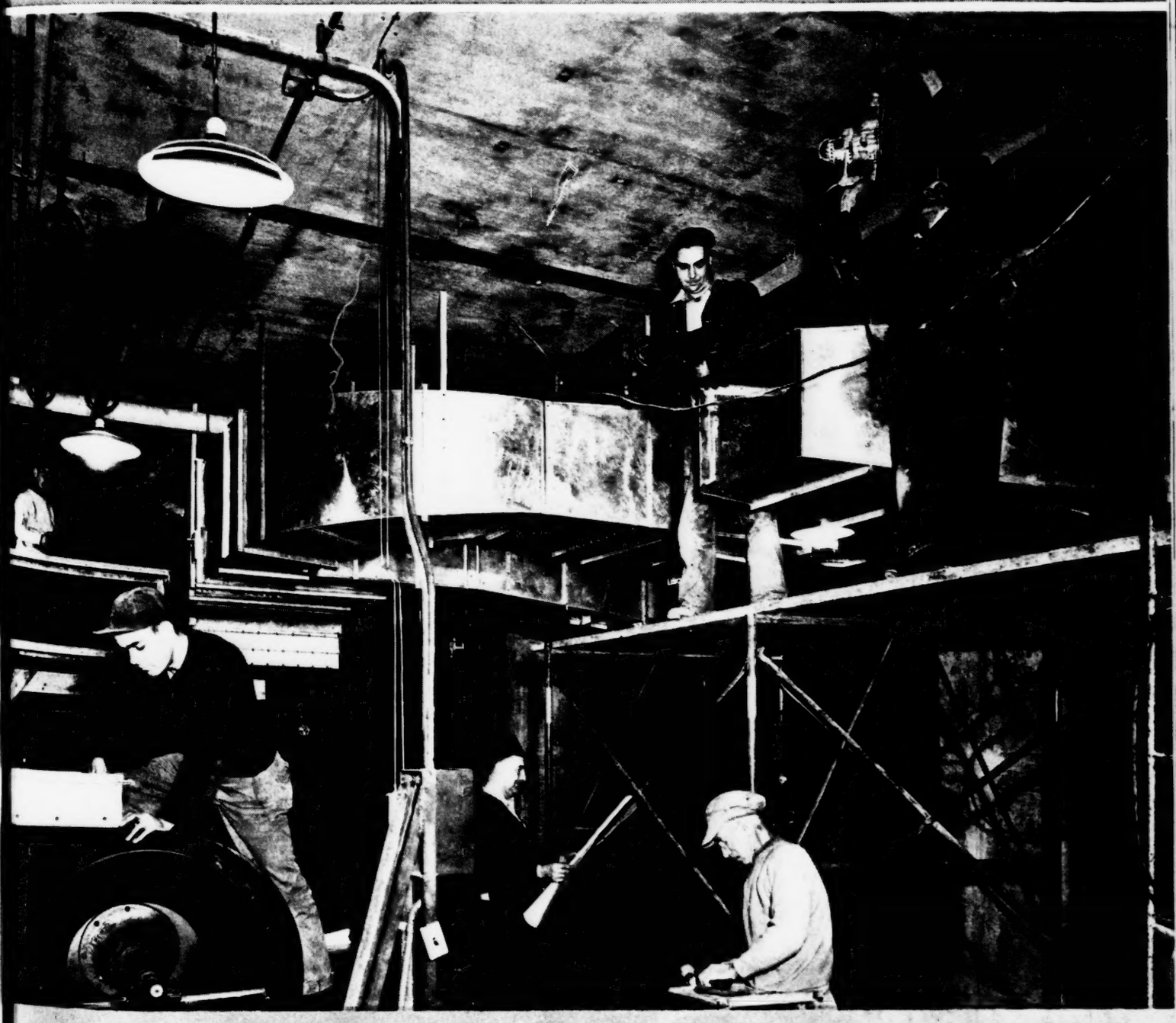

Sheet metal workers find aluminum ductwork has many favorable handling properties . . . page 95

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Heat and Moisture Transfer in Metal Houses . page 69

How to Remove Heat from Electrical Apparatus . page 78

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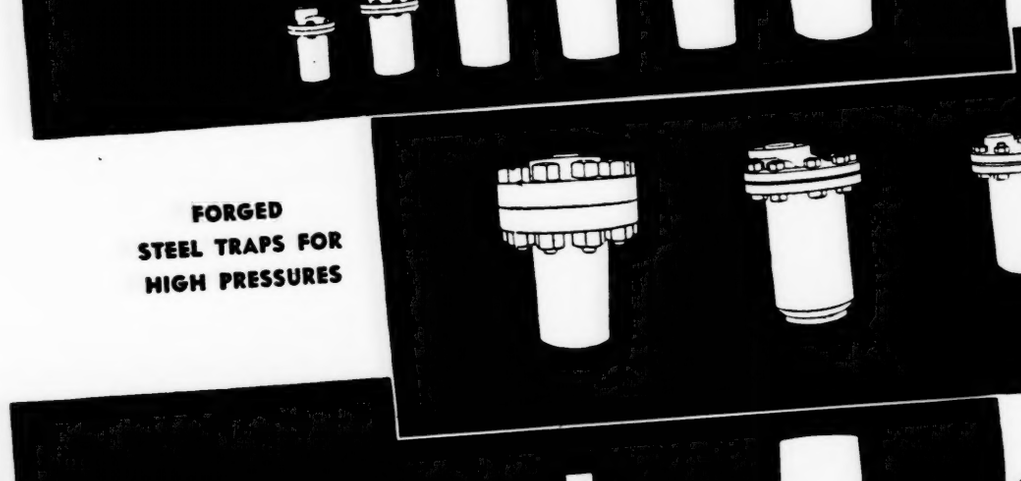

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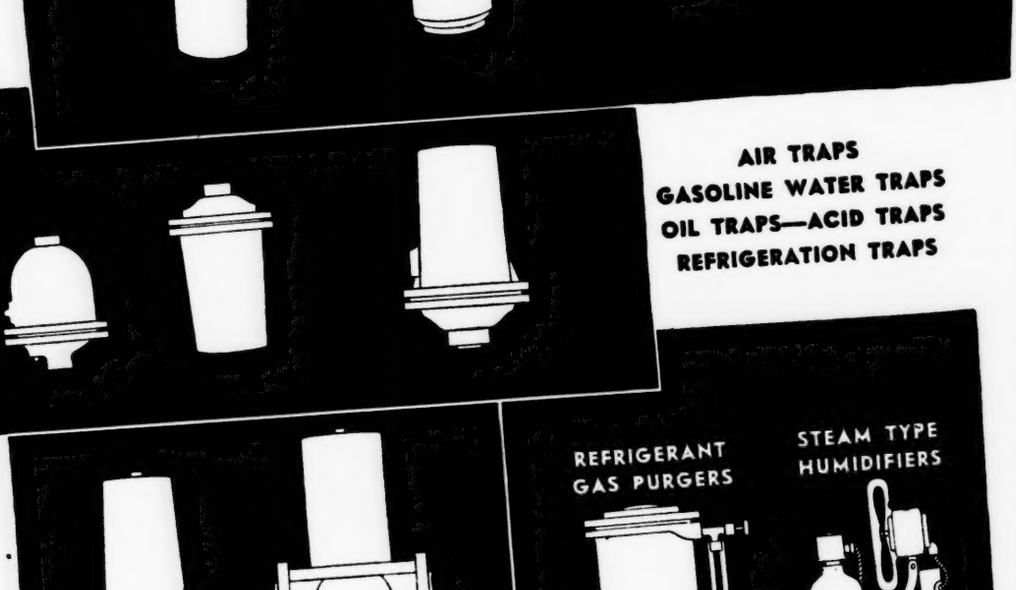

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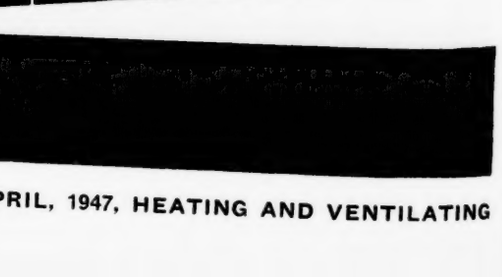

ARMSTRONG STEAM TRAP

TRAPS

VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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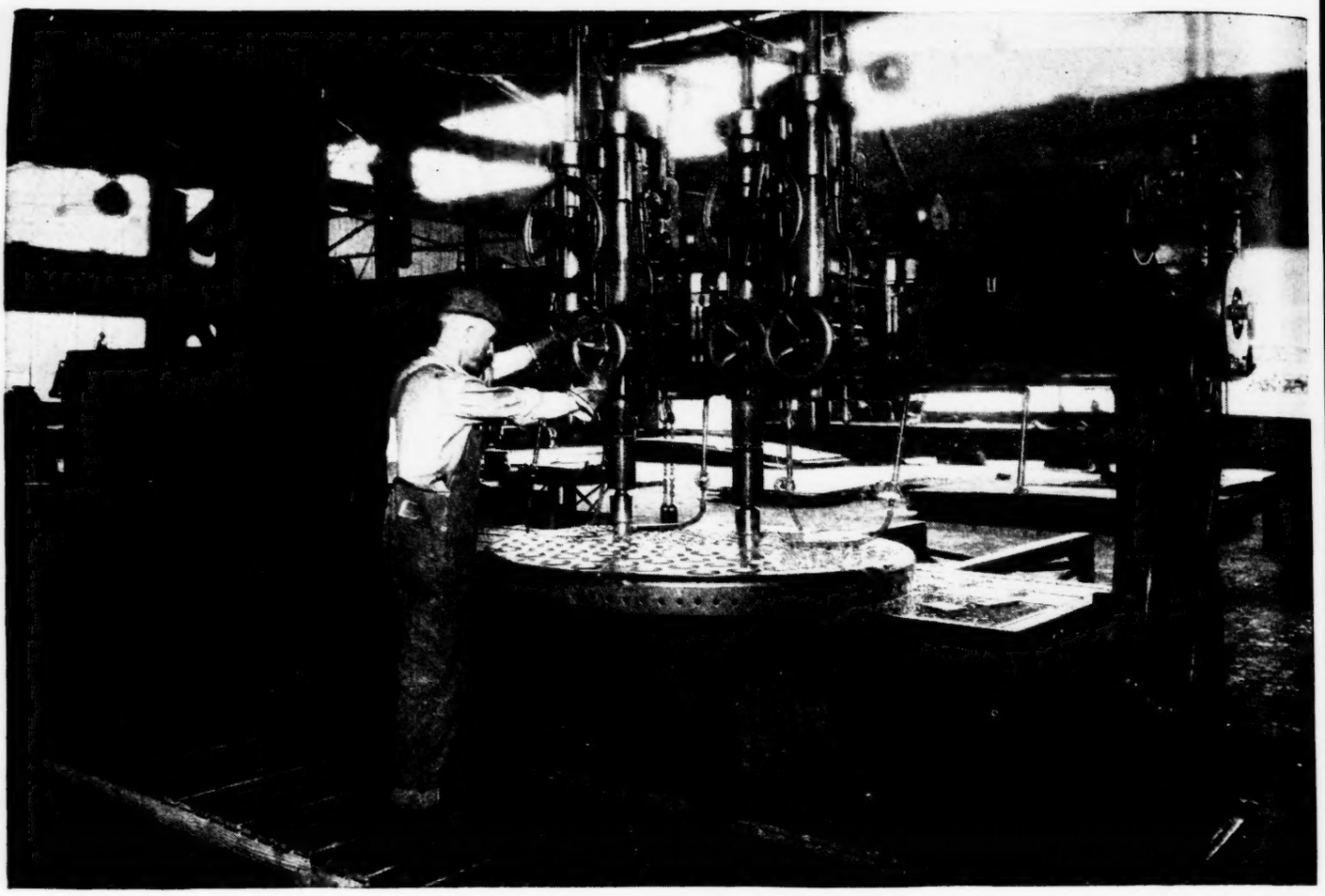
PUBLISHERS OF MACHINERY & MACHINERY'S HANDBOOK
The INDUSTRIAL PRESS

THIS MONTH

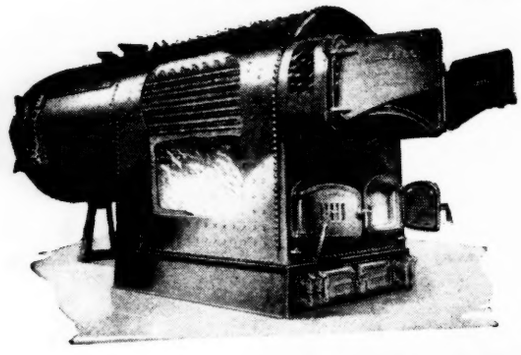
A working knowledge of contract law may help avoid costly litigation. This month's reference section, by Attorney Leo T. Parker, page 83, begins a series of higher court case analyses of special interest to heating and ventilating engineers and contractors.



"HAND TAILORED" OF STEEL

KEWANEE

HEAVY DUTY STEEL BOILERS



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Washington News

LORING F. OVERMAN

Information Sources
OTS, for Instance
Facts for Industry
Patent Office

For the last half-dozen years this column, perforce, has been concerned primarily with what members of the heating, ventilating and air conditioning industries could or could not do under Washington directives, regulations, prohibitions and the like. Perhaps the time has come to examine some of the other merchandise Washington has to offer—the data, the source material, the surveys and reports, the war-revealed secrets—the technical advancements that will sooner or later find their way onto the drafting boards and into the products and services of our industry.

It should not be assumed that the industry need give no further attention to Capitol Hill or to those who still think that "planning" can't be much good unless it originates on the Potomac. The idea of Big Government did not end with last Fall's elections, any more than peace came to the world when the fighting stopped. Pending legislation—offers proof of that, but it is refreshing to take a look at Washington with an eye to finding what might be helpful, instead of always expecting the worst.

OTS, for Instance

At the Office of Technical Services in the Department of Commerce, for example, may be found what Russia's Molotov told our Secretary of State amounted to 10 billion dollars worth of German industrial secrets. Molotov implied that the United States swiped them, entitling Russia to another $10 billion in reparations of other types from Germany. But Secretary Marshall told Russia just what this column is telling now—that the data is public property and that Molotov can have copies of all of the data, merely by paying the low cost of making copies.

Now whether all of this $10 (?) billion worth of secrets will include any of direct interest to the heating, ventilating and air conditioning industry remains to be seen, but it's worth a look by those concerned with production and design. That they will not be disappointed is forecast by some of the amazing discoveries made by searchers from other industries. It will be recalled that the Germans were far ahead of the United States in jet propulsion, and only a step behind in atomic utilization—so there is little reason to assume their scientists overlooked industrial and commercial heating, ventilating and air conditioning.

As an example from another field, technicians of this country's light alloy forging industries have been awed and amazed at a 30,000-ton German forging press making it possible to forge shapes and sizes never before attempted. Yet presses of this type were in actual operation in Germany when the Allies closed in, stamping out airplane engine mountings 10 feet long and airplane wheels more than a yard in diameter, the latter in only two operations.

At the other end of the size scale, OTS reports tell of efficient electrical motors many times smaller than anything used in this country, produced and operated at a fraction of the cost of U. S. models serving similar purposes.

Worth Investigating

So whether a current heating and air conditioning problem involves the world's smallest or its largest, there is reason to believe that a little time spent with OTS records might render unnecessary many hours or weeks of trial and error. Too, if no particular problem is involved, indulging a little curiosity at the OTS office might prove a thought starter.

There are three common ways of finding out what's in the German records.

1. Subscribe to the weekly Bibliography of Scientific and Industrial Reports, offered at $10 per year, from the Superintendent of Documents, Washington 25, D. C.

2. Write to Reference Service, Office of Technical Services, Washington 25, D. C., for information on the reports available on any specific subject in which you are interested.

3. Visitors in Washington may call at the offices of Reference Services, Room 1325 Department of Commerce, and consult the card index.

OTS officials report that their chief problem is sheer volume. To OTS comes not only all of the German material but also, by Presidential order, every scientific and technical document, once secret, which the Army, Navy, Office of Scientific Research and Development, or other agency, can now release for public use.

Each document is catalogued and a brief abstract is written. The original document is then sent to the Library of Congress, Library of the Department of Agriculture, or Army Medical Library. These libraries will make photostat or microfilm copies on order from OTS. Each week some 1,000 new abstracts are published in the Bibliography of Industrial Reports. By the end of 1946, more than 55,000 documents were in the files and more than a third of a million copies of them had been sold.

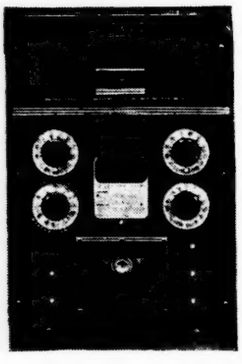
Never before, officials say, has there been a distribution problem of such magnitude—an attempt to get into use the complete scientific and technical story of American and German wartime developments. No one has been able to evaluate the reports and documents as they become available. No one has had time to separate the significant from the trivial, the important from the obsolete.

No one has had time to pull together documents on the same subject, to compare them, edit them and prepare a synthesis. All that has been done is to abstract,

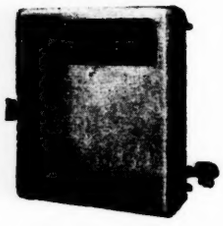
TEAMWORK IS A BASIC FACTOR IN THE EFFICIENT OPERATION OF A HEATING SYSTEM

AUTOMATIC SELECTOR

RESISTANCE THERMOMETER



CONTROL PANEL



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The coordinated "System" control consists of control panel usually located in the boiler room, room resistance thermometer, heat balancer, selector and control valve.

DUNHAM

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D447F

catalog, and index—and invite American industry to judge their practical value. Not to be overlooked, however, is the fact that translation is the greatest obstacle to this evaluation, at least in the case of 10,000,000 pages of German language material. Delivery of this material is by photo copy. From that point on the industrial investigator is on his own.

Facts for Industry

A source of information closer to the day-to-day needs of the industry is the Bureau of the Census, U. S. Department of Commerce, Industry Division. Each month an Intermediate Metal Products Unit reports on orders booked for steel boilers for a current reporting period (usually two months earlier than the date on which the report is released); a Plumbing and Heating Equipment Unit reports similar information for mechanical stokers and warm air furnaces. Current reports, released March 24, cover January operations.

In mechanical stokers, for example, the January report reveals that factory sales of mechanical stokers of all types decreased to 4,497, approximately 43% less than the 7,933 sold in December. Stokers sold for residential use (other than in apartment houses) were only 27% as large as in January, 1946. Sales of stokers for use in small apartment houses and small commercial heating plants in January were only 62% as large as in the same month of 1946. These two types accounted for 90% of January sales.

New orders for steel boilers booked during January totaled 1,393 for boilers of 100 sq ft or over; total heating surface 1.4 million sq ft. During January of last year orders were placed for 1,381, with a total heating surface of 1.6 million. Of the January 1947 total, 755 boilers, or 54%, were for stationary power boilers of over 15 lb pressure; 636 were heating boilers, and 2 were marine boilers.

Factory shipments of warm air furnaces in January totaled 74,032 units valued at almost $11 million, approximately the same number and value as reported for December. A 9% decrease in shipments of gravity air flow types between December 1946 and January 1947 was offset by a 9% increase in the forced air type. Furnaces built for solid fuels represented 44% of the total; gas-fired 38%, and oil-fired 18%. The report included information on direct-fired unit and blower-filter units in addition to warm air furnaces and floor and wall furnaces. January shipments of 6,986 direct-fired unit heaters were 26% above the 5,538 units shipped in December. The number of blower-filter units sold separately totaled 4,394 units valued at $172,000—5% below the preceding month.

In such figures as the foregoing, members of the industry will find tips on trends, clues as to availability, and so on. Details may be secured monthly by writing to the Department of Commerce unit issuing the report.

Vets Booklet Published

No. 59 (and one of the newest) additions to the Department of Commerce's Industrial Small Business series of publications is an 84-page booklet, "Establishing and Operating an Air Conditioning and Refrigeration Business." The booklet is slanted particularly to veterans interested in either finding or creating a place for themselves in the business world. Previewed prior to publication by more than a score of individuals and organizations in the air conditioning and refrigeration field (including N. Wolpert, associate editor, HEATING AND VENTILATING), the booklet offers basic information and counsel on establishing and operating a business in the air conditioning and refrigeration field.

"It offers no magic formula for success," the preface explains, "but it does suggest some practical standards by which the interested reader can measure his qualifications and prospects, as well as gain some understanding of the problems involved."

The booklet would appear to serve a dual purpose—that of attracting desirable prospects to the field, while at the same time leaving the impression that the decision to strike out on a new venture is one that should not be taken lightly. For the indoctrination of new employees, the booklet would appear to represent a splendid introduction to the industry as a whole. Copies are available at 20 cents each through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Patent Tips Too

Available upon request without charge is the Patent Office "News Letter", a brief resume of goings on at the U. S. Patent Office, which is back in business at its old stand in the Department of Commerce building, after a wartime sojourn in Richmond.

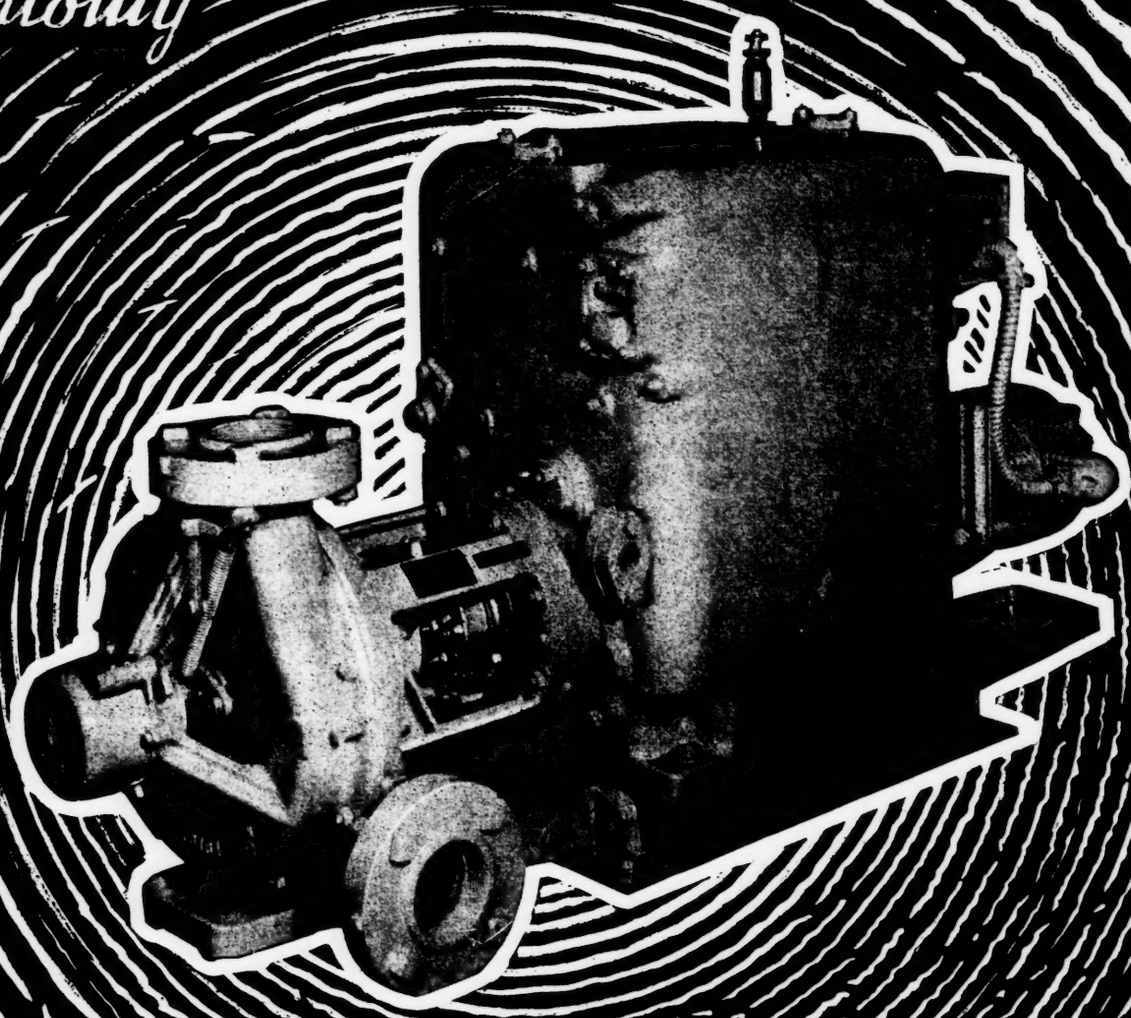
Added to its services is a reception center where visitors are received, given non-technical information, and directed to sources of information. Observes the "News Letter": "No longer will visitors have to grope their own way to find a particular office. The reception service has been established in response to requests from attorneys, businessmen and inventors for assistance in facilitating their contacts with the Patent Office." Can it be that the new Washington is also going to give interested consideration to the "customer"?

Perhaps a clue to increased interest in the customer lies in the announcement (which should please taxpayers) that many industry reports heretofore issued by the Department of Commerce without charge have now been placed on a paid subscription basis. Along with the swing-over from free distribution the reports will be more comprehensive, the Industry Division of the Department of Commerce explains.

Non-Housing Permits Up

Non-housing construction is now nearing the $50 million-per-week top limit authorized in recent relaxation of the Veterans Housing Program Order. During the week of March 11, CPA field officers approved 2,081 non-housing projects, to cost approximately $47,287,202. Rejections totaled 823, calling for construction to cost $23,893,289.

Centralized Heating Economy



A RETURN LINE VACUUM PUMP THAT CUTS HEATING COST.

This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

More important, this pump insures absolutely uniform circulation in system. That means continuous steam economy.

Simple, compact, one moving element, no wearing parts, no internal lubrication. Bulletin No. 203 gives the facts. Your copy is waiting.

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Ultraviolet Sanitary Ventilation

WILLIAM T. ANDERSON, Jr.
Director of Research, Hanovia Chemical & Mfg. Co., Newark, N. J.

The author outlines the present status of ultraviolet irradiation in ventilation, its germicidal effect, describes two methods of accomplishing air sanitation with ultraviolet, and presents formulas for computing lamp requirements for each method.

OCCURRENCE of colds, influenza, and other epidemic diseases are infrequent during the summer months when buildings, buses and other enclosures are freely ventilated by out-of-doors air, due to the fact that fresh air out-of-doors is practically free from pathogenic bacteria and viruses. The opposite is the case during the winter, when the conservation of heat and the avoidance of drafts greatly restrict the extent of fresh air ventilation. Numerous tests have confirmed that germs and viruses of the common respiratory infective diseases are frequently present in unsafe concentrations in the air of occupied rooms which are inadequately ventilated. It is the purpose of sanitary ventilation to provide air with a safe bacterial content for such enclosed spaces.

The subject of air-borne bacteria and their relation to infection has been exhaustively investigated at the University of Pennsylvania by W. F. Wells whose many reports are recommended for study of fundamental concepts. It suffices to state here that every person is a carrier of bacteria, and at some time these may become pathogenic. As a result of the respiration process, talking, coughing and sneezing there is a continual interchange between the air and the persons in a room whereby bacteria may be transferred from one person to another. Not all bacteria are pathogenic, but if a pathogenic organism be transferred to a new host, an infection may result. Sanitary ventilation can maintain the bacterial content of the air in a room at a safe level and prevent infections resulting from air-borne bacteria or viruses.

Measurement of Sanitary Ventilation

Summer ventilation with doors and windows open prevents the spread of infection, with the result that the incidence of epidemic diseases is at a minimum. When doors and windows are closed, the measurement of sanitary ventilation is the reduction in hazard of breathing micro-organisms released into the air of the room by some infector.

Measurements of air pollution can be made only by experienced bacteriologists, and unfortunately not even these are completely in agreement on equipment and procedures. However, very many tests have been

Vials of streptomycin pass under germicidal lamps on way to aluminum cap machine

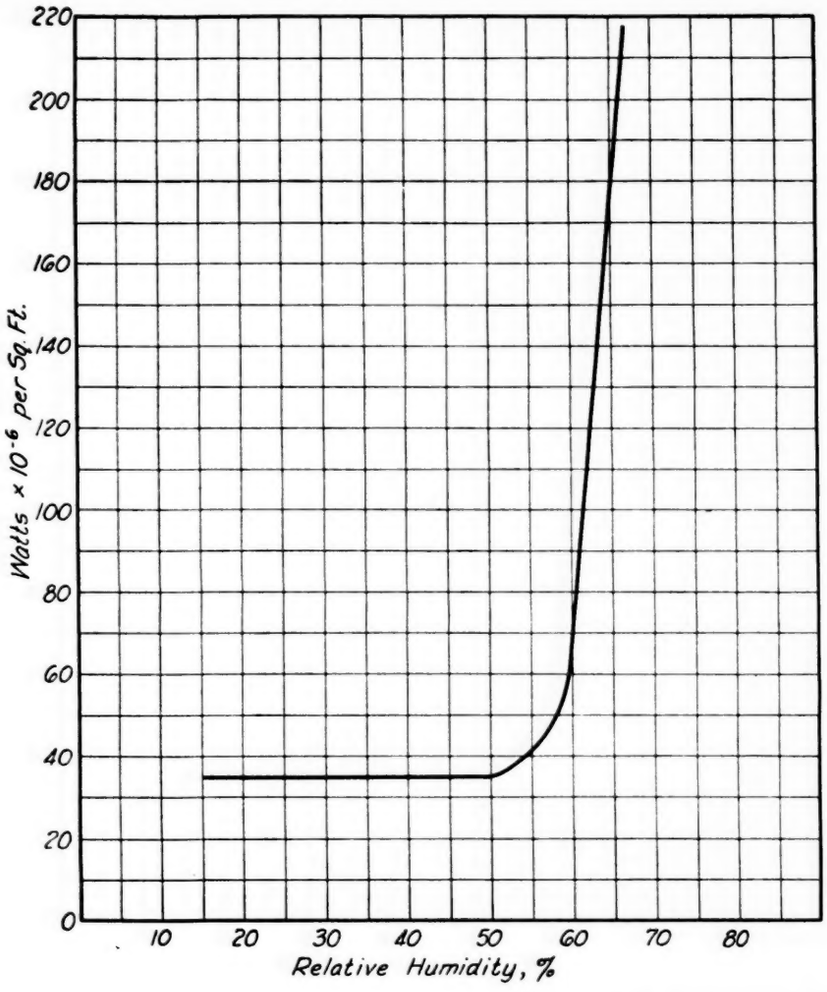

Fig. 1. Variation of energy of uniform radiation, 2537 angstroms, in the lethe per hour with relative humidity

made which indicate the presence of air-borne bacteria in occupied enclosed rooms.

The concentration of bacteria in air is a variable, and at any one time is in dynamic equilibrium as a result of factors such as natural death rate, settling, and removal and addition by the respiration process. Talking, coughing and sneezing greatly increase the number of bacteria in the air. Methods of measurement rarely evaluate more than a fraction of the air-borne bacteria because of the difficulty of apprehending all of them. Petri dishes and the Wells centrifuge with blood agar are practical methods for a relative evaluation of air-borne bacteria. Typical measurements made by these methods are given in Table 1. Values are all relative and have been rounded to the nearest ten.

Degree of Sanitary Ventilation Required

The absence of epidemics in summer indicate that ventilation is then adequate. During the winter months epidemics do occur, and inadequate ventilation may be a contributing cause. At such a time high rates of ventilation by fresh out-of-door air become impractical because of drafts and high cost.

Sanitary codes in some States require that school rooms should be supplied not less than 30 cu ft of pure air per person per minute. For a school room with 30 pupils this minimum usually amounts to only three to four air changes per hour. Ventilation tests made during the past decade have indicated that a minimum of 500 cu ft of pure air per person per minute, or 60 to 75 air changes per hour for the typical room, are required if the epidemic hazard by air-borne bacteria is to be eliminated.

In some enclosed spaces of very high occupancy such as clinics, factory assembly rooms, theaters, railroad cars and buses, a ventilation rate in excess of 100 air changes per hour may be required for adequate sanitation. Ventilation by outdoor air at these rates is not practical.

Equivalent Sanitary Ventilation

The objectives of sanitary ventilation may be attained by either an adequate number of air changes or a proportionate destruction of the air-borne bacteria by some suitable means. This latter method may be considered to be an equivalent sanitary ventilation.

Wells has defined the equivalent of one complete air change by pure air as the *lethe*. Thus the quantity of air required for a lethe by definition varies with the size of the enclosure. Neither does the definition have a time involved; the time taken may be one minute or two hours. However, bacteriological tests in rooms have shown that each person in a room which contains a number of persons must receive 500 cu ft of complete air change by pure air per minute if the air he breathes is to be maintained always in a sanitary condition. The pure air can be obtained by the introduction of fresh out-of-doors air, or by the equivalent pure air as a result of sterilization by ultra-violet radiations. The sanitary result is the same. Therefore, by definition of the lethe, each person needs 500 cu ft lethes per minute. Provided a room is unoccupied so that there be no new source of infection, one complete air change, or the sanitary equivalent of one complete air change, will reduce the initial air, carbon dioxide, dust, air-borne bacteria, and odor to 36.8% of the original. This is a reduction by 63.2% in the bacterial content of the air of the room. A second complete air change will attain a disinfection of 86.5%. Repeated air changes will reduce the bacterial content to a very low value, but a strictly sterile condition can never be attained.

Table 1—Relative Number of Bacteria in Air (Blood Agar at 37 C)

Location	Condition	Colonies per 10 cu ft
City	Out-of-doors in summer	30
City	Out-of-doors in winter	10
School room	Old bldg., winter, 33 occupants	250
School room	Modern bldg., winter, 30 "	150
Clinic, children	Old bldg., winter, 25 persons	800
Office	Air cond., winter, 110 persons	70
Office	Nat. vent., winter, 80 persons	240
Hospital ward	Old bldg., winter, 16 children	550
Operating room	Winter, 8 persons	80

This rate of reduction applies only to an unoccupied room. An occupied room contains sources for reinfection of the air with the result that a condition of dynamic equilibrium always exists between removal and reinfection. Sanitary ventilation must maintain this equilibrium concentration below the hazard of epidemic.

Because it is frequently impractical to provide sanitary ventilation by actual air changes, equivalent sanitary ventilation must be employed, and must provide not less than the previously mentioned 500 cu ft lethes of pure air per minute per person, or 30,000 cu ft lethes of pure air per hour per person.

Ultraviolet irradiation of the air may provide equivalent sanitary ventilation. One lethe of disinfection results from uniform radiation of wavelength 2537 angstroms at an intensity of 35×10^{-6} watt hour per sq ft in a room in which the relative humidity is below 50%. The changes in the ultraviolet energy value for the lethe with relative humidity are given in Fig. 1, which has been compiled from the researches of Wells and Whisler. Since the moisture in a room during the colder months condenses mostly upon the colder walls and windows, the relative humidity is usually below 50%. However, if the humidity should be higher than 50%, a correspondingly greater energy value for the lethe must be employed when estimating the ultraviolet requirements.

The two methods in use for air sanitation by ultraviolet are: (1) the *upper air irradiation* method, and (2) the *air duct irradiation* method. By method (1) the air in the upper portion of the room is maintained at a high degree of sterilization by ultraviolet irradiation. The air below the 7-ft level receives no ultraviolet and is maintained in a sanitary condition by dilution with sterilized air from the upper portion of the room by a process of natural air interchange. Method (2) applies mostly to an air conditioning system with recirculation in which the recirculated air passes through ultraviolet radiations before venting into the room.

Upper Air Irradiation Method

Personnel Safety. Ultraviolet radiations may be used with complete safety for the occupants of a room if a few simple precautions are taken. Ultraviolet radiations employed in sanitary ventilation are usually produced by an electric discharge through mercury vapor contained within an envelope transparent to radiations at 2537 angstroms. Radiations at this wavelength which are lethal to bacteria will also produce skin erythema and eye discomfort. Observations made by the writer on human subjects who were exposed to a range of intensities of 2537 angstroms radiation for two-hour periods indicated that, for a 24-hour period, the intensity of ultraviolet at this wavelength should average at the skin and eye level less than 0.0002 watt per sq ft; that is, less than 0.2 microwatts per sq cm. This confirms the advice of the Council on Physical Medicine, American Medical Association that the maximum safe intensity for a 24-hour period is 0.1 microwatt per sq cm of 2537 angstroms radiation.

Radiation intensity required for sanitary ventilation is considerably in excess of these tolerance limits. It is, therefore, absolutely essential that the ultraviolet lamps be located in such a manner that the occupants of the room may at no time nor in any position receive any direct irradiation, and that reflected radiations be below the tolerance limits. This latter requirement necessitates that finishes and appurtenances of the room have low reflectivity for utraviolet at 2537 angstroms, preferably less than 10%. Suitable materials with their reflectivities are given in Table 2.

Table 2 — Materials of Low Reflectivity for Use with Bactericidal Lamps

Material	Condition	Reflectivity Percent
Glass	Brick, mirrors, lighting globes	4-6
Enamels	Baked, any color and white	5-10
Oil paints	Lead, any color and white	5-10
Oil paints	Zinc, any color and white	3-6

Water paints and papers frequently have high reflectivity for ultraviolet at 2537 angstroms. Their use should be avoided.

Ozone is a gas whose molecules consist of three atoms of oxygen whereas the oxygen of the air consists of molecules of two atoms of oxygen. Ozone is not produced by the radiations at 2537 angstroms which are used for air sanitation. However, shorter ultraviolet rays can produce some ozone from the oxygen of the air. Ozone, when present in concentrations better than 0.01 part in one million parts of air, has a definite odor. In concentrations of 0.1 part per million of air ozone is objectionable, and irritating to the mucous membrane of the nose and throat. Since some ultraviolet lamps which produce ultraviolet at 2537 angstroms also produce some shorter radiations which are ozone producing, lamps used for air sanitation should be procured on the basis of ozone production of less than 0.01 part per million part of air in a closed room. Compliance with this requirement may be readily checked by the nose test.

Lamp Location. Lamps are either suspended from the ceiling, or mounted upon the walls or upon columns. The minimum distance from the floor to the lamp is 7 ft. The ultraviolet radiation tubes must be completely shielded from the view of all occupants of the room. The shields may serve also to reflect the ultraviolet upward and to improve the efficiency of the irradiation process. However, it is well to remember that reflectors are useful as such only when maintained in a clean and dust-free condition.

Lamps which are suspended centrally in a room are more efficient than the same lamps when mounted upon a side wall because in the former instance a greater solid angle of direct radiation may be utilized to intercept the air-borne bacteria which are therefore subjected to the lethal action of the radiations for a longer period of time.

Ceiling Height and Ray Length. The sterilizing action of the ultraviolet becomes more effective as the

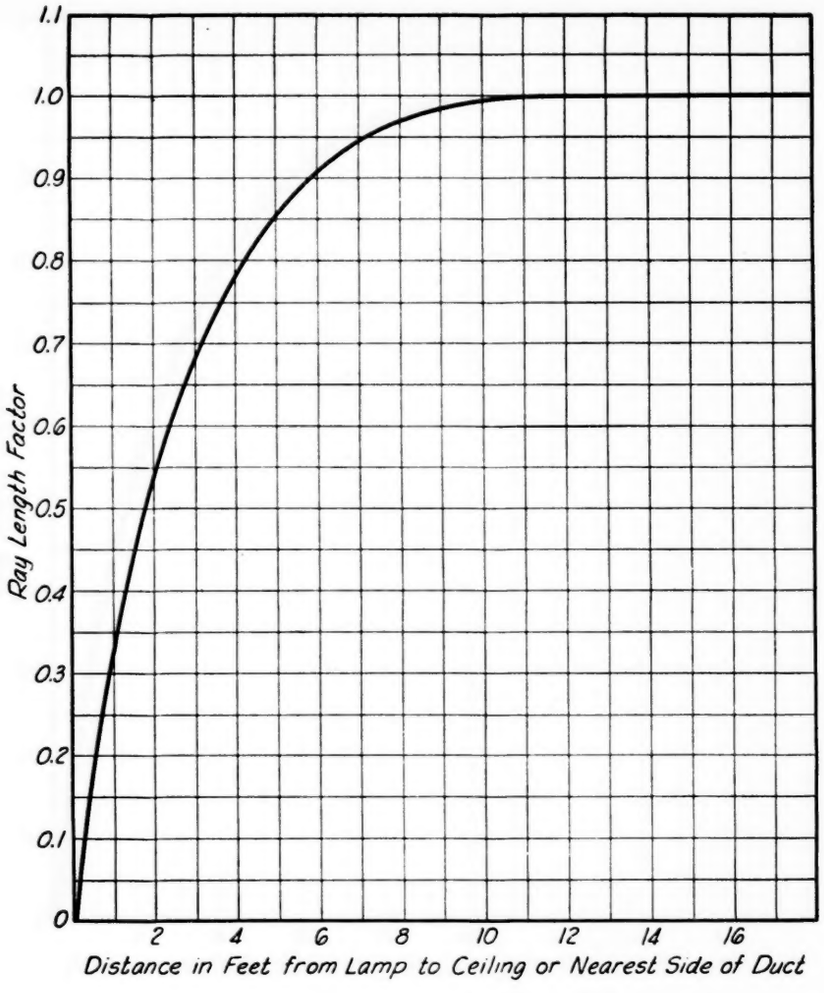

Fig. 2. Ray length factors for various distances between lamps and ceiling, or between lamps and nearest duct wall

ray length increases because the bacteria are exposed to the radiations for a longer time. Since lamps are usually suspended or mounted 7 ft from the floor with rays projected upwards, the ceiling height of the room determines to a considerable extent the effective ray length. The average ray lengths, their relation to ceiling height, and their effect upon the lethal action by the ultraviolet have been determined experimentally. Within limits, the ultraviolet output from lamps must be increased as the ceiling height decreases, and conversely, be decreased as the ceiling height increases. Obviously, since the lamp is fixed at a distance of 7 ft from the floor, as the ceiling height decreases and approaches the lamp, a point will be reached where the requirement for ultraviolet output exceeds practical considerations, such as personnel safety and the economics of the process. Conversely, as the ceiling height increases and moves away from the lamp, a point will be reached beyond which the ultraviolet output cannot be reduced. Further increases in ceiling are therefore without effect upon the irradiation process.

The effectiveness of a lamp relative to the distance between the lamp and the ceiling is given in Fig. 2 The factors have been called *ray length factors.* They indicate that a lamp which is one foot from the ceiling is only about one-third as effective in sterilization as the same lamp would be if the distance to the ceiling were 10 ft.

Lamp Ratings. Lamps are rated in watts of total flux at a wavelength of 2537 angstroms. Most manufacturers specify the total flux after the first initial 100 hours of operation since the most rapid depreciation in ultraviolet output occurs during that time. Lamps depreciate in output continuously during their operable life. Since the rate of depreciation varies with types, and individual lamps, it is not possible to assign any definite useful life to lamps. In practice it has proven satisfactory to provide about 50% total flux, based upon initial ratings, than the requirements indicated.

Efficiency of Upper Air Irradiation Method. The effectiveness of the method depends upon rate of dilution of the contaminated air in the livable portion of the room by the sterilized air from the upper irradiated portion of the room. This interchange of air is assisted by the natural air drafts, temperature gradients, and motion of occupants in the room.

The writer attempted in 1940 to measure the air interchange between the upper and lower air strata in closed unoccupied rooms by the ozone method. Conditions were very similar to those encountered in upper air irradiation. The ozone was produced by ozone generators mounted 7 ft from floor and consisting of thin wall quartz mercury discharge tubes. Only the air in the upper portion of the rooms were exposed to the ozone producing radiations (1849 and 1900 angstroms) so that any ozone found in the lower portion of the rooms could result only from air interchange. The relative concentrations of ozone in the two air layers were determined by simultaneously exposing prepared starch-iodide papers in the two layers, protecting them from radiations, and timing with a stop-watch to 1/5th second the time required to match a blue comparison standard. By starting the experiments with zero detectable ozone, and timing until easily measurable quantities were in both zones, it was possible to obtain some measure of the rate of interchange between the two air zones. The results were calculated to approximate rates of recirculation per hour and are given in Table 3.

Results were interpreted to indicate that there was sufficient natural interchange between the upper and lower air layers in a room to make the upper air irradiation method a practical means for air disinfection. It was believed that when the rooms were

Table 3 — Air Recirculation in Rooms by Ozone Method

Type of Room	Volume, Cubic Feet	Ceiling Height, Feet	Approx. Rate of Recirculation per Hour
Clinic	36000	20	110
Operating	16000	40	130
School	18000	15	70
Office	7800	12	60

occupied, and the heating plant was functioning, even a greater rate of recirculation would exist.

Wells tested air interchange in 1945. He used a bactericidal method with lamps at 7 ft height, provided with a visored low angle beam, and an average intensity of 0.02 watt per sq ft, 2537 angstroms. He reported 120 to 220 equivalent overturns per hour between the upper and lower layers of air, which are just about twice the values indicated by the ozone tests.

It appears that this method for air sanitation can be highly effective in maintaining the bacterial content of the air in the livable area at the necessary low value. However, the theoretical and laboratory requirements for ultraviolet energy have been found to be inadequate in practice. The writer has always found it necessary to employ a factor of safety of 4 or 5, preferably the latter. This would indicate that the radiation efficiency is about 20%. Factors which lower the efficiency are: lower than rated output from tubes because of low voltage supply, inability to employ the full output of the tubes because of the necessity for shielding, variations in reflectivity by reflectors, absorption of 2537 angstroms radiation by dust particles in the air, and protection of bacteria by dust particles and other bacteria.

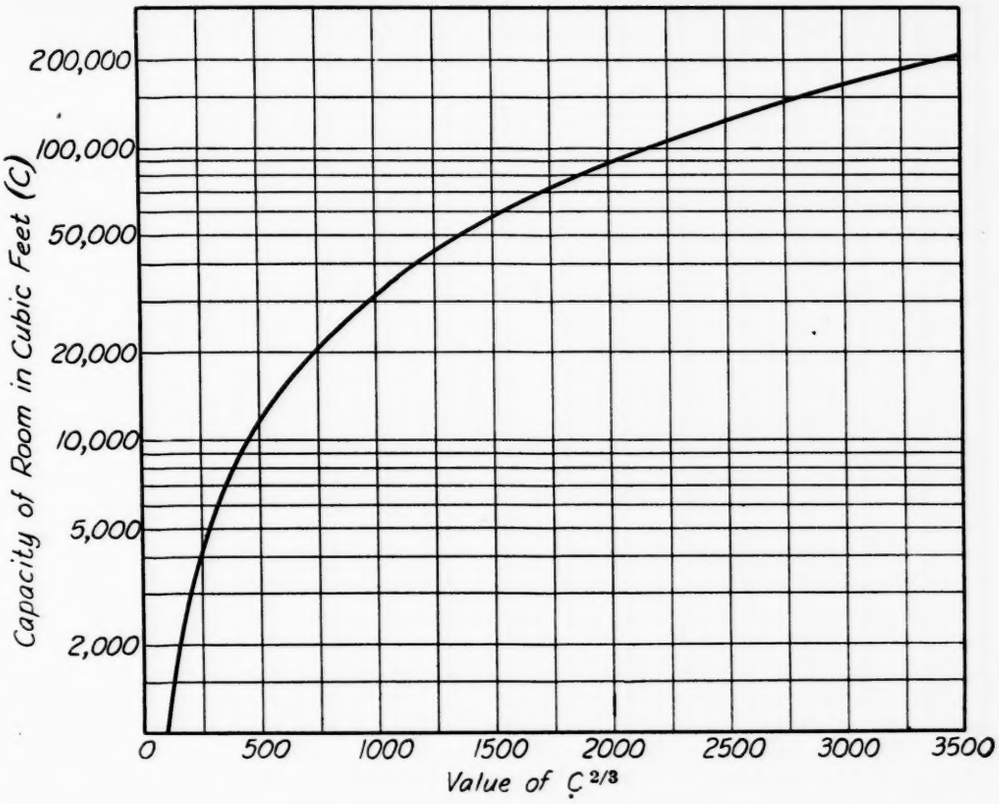

Fig. 3. Values of $C^{2/3}$ for various values of C, where C = room capacity in cubic feet

Survey. The factors which should be considered when an installation is surveyed are:

(a) C = volume of the room, cubic feet;
(b) R = ray length factor for distance between lamps and ceiling (Fig. 2);
(c) Ceiling height, feet.
(d) N = maximum occupancy of the room (number of persons); and
(e) Relative humidity, normally taken at 50%.

Computation of Lamp Requirements. For use in computing lamp requirements, the following four formulas are given: Lethes per hour =

$$\frac{N \times \text{30,000 cu ft lethes per hour per person}}{C} \qquad (1)$$

$$I_t = \text{lethes per hour} \times 35 \times 10^{-6} \text{ watt per sq ft} \qquad (2)$$

where I_t is the theoretical average intensity, or uniform cubic flux density in the room, in watts per square foot of radiation at wavelength 2537 angstroms.

The energy value, 35×10^{-6} watt per sq ft, applies for relative humidities of 50% and less. For higher humidities, see Fig. 1.

$$E_t = I_t C^{2/3} \qquad (3)$$

where E_t is the theoretical total flux in watts of radiation at wavelength 2537 angstroms, i.e., lamp rating. Values for $C^{2/3}$ for different room volumes are given in Fig. 3.

$$\text{Number of lamps} = \frac{E_t \times 5}{L\ R} \qquad (4)$$

where *5* is the efficiency factor for suspended lamps, *L* is the lamp rating for the lamp selected in watts of 2537 angstroms radiation, and *R* is the ray length factor (Fig. 2).

If the lamps, instead of being centrally suspended are wall mounted, the radiation efficiency is not so high; additional lamps are required. For wall mounted lamps, in Equation 4, an efficiency factor of *7* should be used instead of a factor of *5*.

Air Duct Irradiation Method

Irradiation of recirculated air in a duct system is far more economical than ventilation by fresh out-of-doors air. More lamps are required for air disinfection in a duct than would be required for the same degree of sanitation if the upper air irradiation method were employed.

The duct method simplifies the protection of the occupants of the room from direct or reflected ultraviolet since all the radiation is contained within the duct. Lamps in the duct must not be viewed by persons in the room.

Because of practical difficulties, an air duct system may not be able to provide the requirement of 30,000 cu ft pure air per person per hour which air sanitation demands. Air duct irradiation may not give the desired results in small rooms of high occupancy. Duct irradiation is the method of choice in many industrial

applications, railway cars and buses, and in rooms which have low ceilings.

In ducts the efficiency of air sterilization is affected by the reduced ultraviolet output of lamps as a result of the cooling action of the air blast, a short ray length which limits greatly the time during which the bacteria are exposed to the lethal action of the rays, and the air velocity. Compensation for the reduced output of lamps is provided by enclosure of the tubes within jackets of ultraviolet transmitting glass which conserve heat and maintain ultraviolet output at about 80% of normal.

Tubes in an air duct do not need to be shielded and the full 360 degrees of solid angle may be utilized. The inner walls of the duct can supplement the direct light from the tubes by reflection. These factors improve the efficiency of tubes in ducts, the average efficiency being about 25%, the efficiency factor being 4.

The average ray length is very short in a duct, and is mostly defined by the minor dimension of the duct or the distance to the nearest duct wall. Using the distance to the nearest wall as the gauge, the ray length factors given in Fig. 2 apply. Distance is measured from the center of the tube, or the center of the duct to nearest wall.

Survey. The factors which should be considered when an installation for air ducts is surveyed are:

(a) V = volume of the air duct, cubic feet;
(b) Volume of the room, cubic feet, (C);
(c) Duct dimensions, feet;
(d) N = maximum occupancy of room (number of persons);
(e) Air flow, cubic feet per hour;
(f) R = ray length factor for distance between the average tube center (take as center of duct) and nearest duct wall. For most purposes the distance can be taken as one-half minor duct dimension; and
(g) Relative humidity, normally taken as 50%.

Computation of Lamp Requirements. The four equations which follow enable the determination of lamp requirements: Requirements for air sanitation in a room are independent of the means for attainment. Therefore the lethe per hour requirements for the room must be satisfied by the air flow from the duct; that is, each person must have 30,000 cu ft lethes per hour. The required lethes per hour are given by a solution of Equation 1. The maximum available lethes per hour are given by Equation 5:

$$\text{Max. lethes per hour through duct} = \frac{\text{air flow cu ft per hr} \times \text{lethes per hr,}}{\text{N} \times \text{30,000 cu ft per hr per person}} \text{ or}$$

$$\text{Max. lethes per hour through duct} = \frac{\text{air flow cu ft per hr}}{\text{C}} \qquad (5)$$

where C is the volume of the room in cubic feet.

$$\text{I}_d = \text{lethes per hr through duct} \times 35 \times 10^{-6} \text{ watt per sq ft} \qquad (6)$$

where I_d is the theoretical average intensity, or uniform cubic flux density in the duct, in watts per sq ft of radiation at wavelength 2537 angstroms.

The energy value, 35×10^{-6} watt per sq ft, applies for relative humidities of 50% and less. For higher humidities, see Fig. 1.

$$\text{E}_d = \text{I}_d \text{V}^{2/3} \qquad (7)$$

where E_d is the theoretical total flux in watts of radiation at wavelength 2537A, i.e., the lamp rating.

$$\text{Number of lamps} = \frac{\text{E}_d \times 4}{\text{L R}} \qquad (8)$$

where 4 is the efficiency factor for lamps in ducts, L is the lamp rating in watts of 2537 angstroms radiation for the lamp selected, and R is the ray length factor based on a distance of one-half the minor duct dimension.

Special Air Sterilization Methods

There are certain special applications for sanitary ventilation which require modification of methods (1) and (2) in that persons in the room are directly exposed to the ultraviolet radiations. A typical example is the hospital operating room in which, if postoperative infection is to be reduced, the surgeon and his staff and the patient must be directly exposed to the rays. This necessitates that persons must wear suitable goggles to protect their eyes and that masks or visors must be worn to shield exposed skin from any direct radiations. The quantity of ultraviolet required is the same as that specified in method (1) but the lamps instead of being mounted with the rays projected upward are mounted to project the rays downward. Excepting for abdominal operations, it is advisable to mount one lamp directly on the operating table light.

In other applications, such as food processing and vaccine production, direct ultraviolet radiations may also be desirable, since a very high degree of air sanitation at the working level is required. Such installations usually require twice as much total ultraviolet flux as the usual application of air sanitation. Personnel must be completely protected from the radiations by suitable clothing and goggles.

In still another special application involving hospital rooms in preparation for new patients the air in the room may be made sanitary by means of a portable ultraviolet unit which radiates in all directions and which is designed for use in an absolutely unoccupied and closed room. Here the intensity of ultraviolet used may be several times the normal requirement.

Procedure and equations for the evaluation of the ultraviolet requirements in equivalent sanitary ventilation have been described. They have been based upon experimentation and practical installations studied during the past 11 years, and appear to adequately achieve the desired results in all ordinary installations. Until further fundamental studies of ultraviolet disinfection correlate the pure air requirements per person with epidemiologic indices, 30,000 cubic feet of pure air per hour per person is the requirement for air sanitation.

Heat and Moisture Transfer in All-Metal Houses

F. G. HECHLER[1], E. R. QUEER[2], and E. R. McLAUGHLIN[3]

THE results of recent tests made for the National Housing Agency in the Climatometer[4] of the Engineering Experiment Station, The Pennsylvania State College, under accelerated test conditions of humidity and temperature are of general interest. These tests, and others now in progress, are part of the testing and research program sponsored by the National Housing Agency and the Office of Housing Expediter to provide needed technical data on the performance of new materials and new types of house construction. Laboratories participating in other phases of this program include the National Bureau of Standards, Forest Products Laboratory, Department of Agriculture, Bureau of Reclamation, and the Public Health Service. Valuable assistance in planning and designing these tests and in interpreting results, as well as arranging for the cooperation of participating firms, was provided by the engineers and technicians of the National Housing Agency Technical Office, which is under the direction of William V. Reed. Ralph R. Britton acted as project engineer for the National Housing Agency, on this work.

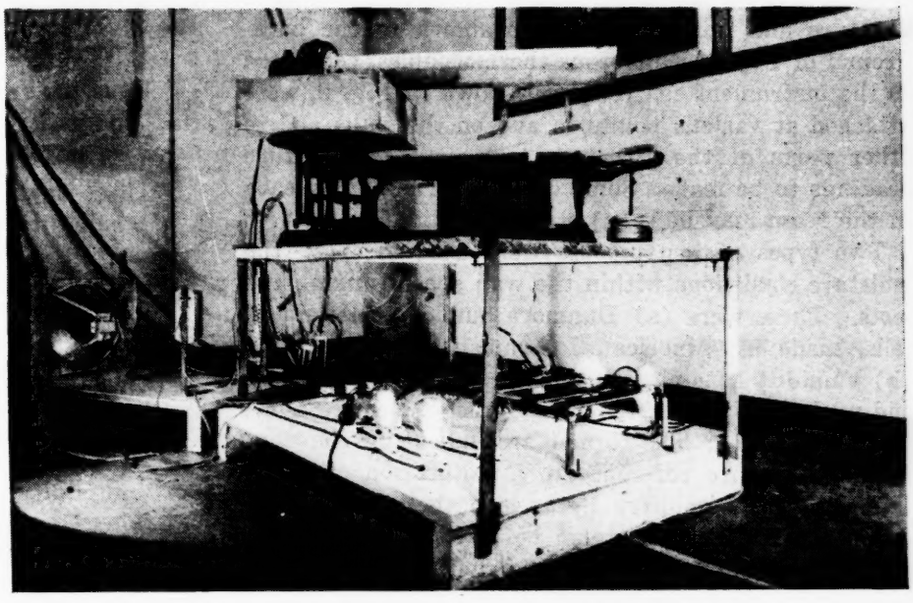

Fig. 1. Heating and humidifying equipment in the test house. Note humidifier on scale.

The tests were made on full-scale model structures to evaluate the performance of several types of all-metal constructions currently proposed for mass production in the national housing program. Two items of particular interest were whether adequate insulation was provided and properly installed to meet the requirements for over-all heat transmission and whether there was a satisfactory vapor barrier with adequate venting or "air wash" to prevent accumulation of moisture in the structure.

Two model structures, each approximately 7 ft × 14 ft × 8 ft high, have been tested. Each structure was complete with walls, floors, roof, door and windows. They were constructed of typical full-size components and a variety of constructions was used in each.

The primary reason for testing the model structures in the Climatometer was to determine whether condensation would accumulate within the insulated spaces, and how such accumulation of water could be prevented or controlled. It has been well established that winter condensation troubles in dwellings are caused by moisture moving from the warm humid inside air, with a relatively high vapor pressure, toward the colder exterior where the vapor pressure is lower. If the moisture escapes on the cold side as fast as it enters the wall on the warm side, there is no serious accumulation and no damage occurs. This immediately suggests the desirability of an effective vapor barrier on the warm side and of a permeable member on the cold side.

Since this was to be an accelerated test and results were desired within a reasonable time, it was agreed that the conditions should be severe. On the other hand, for the results to be valid the conditions should not be more severe than those actually found in average maximum cases. Excessive humidities are frequently encountered in small dwellings where the concentration of personnel per unit volume is high. From a survey made by the Bureau of Standards it was found that a vapor pressure difference of 0.125 lb per sq in. would meet these requirements. This corresponds to an inside temperature of 70F and a relative humidity of 45% (dew point 48F) and an outside temperature of 20F and a relative humidity of 78% (dew point 15F).

Electric heaters, thermostatically controlled, were

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[4]For a description of the Climatometer—An All-Weather Room—See HEATING AND VENTILATING, September, 1945.

used to heat the test house to 70F. The desired humidity was maintained with a fan blowing air onto the surface of water in a pan placed on scales weighing to one gram. The fan was automatically started and stopped as required by a hair element humidistat. The heating and humidifying equipment in one of the test houses is shown in Fig. 1. A remote reading, remotely controlled wet and dry bulb thermocouple hygrometer was used to check periodically the humidity in the room. This hygrometer and a recording hygrothermograph, giving a continuous record of both temperature and humidity are also shown in the background of Fig. 1. Numerous thermocouples, connected to the instrument control panel shown in Fig. 2, were attached at various points in and on the walls and to other parts of the structure to permit temperature readings to be made. Some of the thermocouple leads in the room may be seen on the walls in Fig. 1.

Two types of instruments were used to check the moisture conditions within the wall spaces during the tests. These were (a) Dunmore humidity measuring cells, made by American Instrument Company, and (b) humidity sensing elements used by the U. S. Navy and made by Friez Instrument Division, Bendix Aviation Corporation. The former are indicating elements only and require reference to a calibration chart to determine the humidity. Because of the small size of the measuring cells, they can be used in small spaces and with a minimum interference with normal operation. The Friez instrument is convenient because it automatically prints a record of both temperature and humidity at a central station at predetermined time intervals. The sensing element is comparatively large, however, and is not adaptable to all locations.

Structures Tested

Data are herewith presented for two all-metal structures, each of which incorporated several types of construction for study. An all-metal structure is one in which the components, such as joists, studs, inner wall, outer wall, ceiling, roof deck, door and window frames, etc., are metal, usually light gauge steel or aluminum. For test purposes a few units in which some more conventional materials were used were also included. A description of the structural units tested is given in Table 1 and Fig. 3.

The model test houses were erected in the Climatometer by the manufacturers' erection crews. The houses were set on wood supports to permit free air circulation around all parts of the structure.

Test Procedure

When this program was started there was, to the best of our knowledge, no past experience to serve as a guide in setting up a test procedure. Consequently, the test conditions had to be evolved as the work progressed. It was assumed that, under the severe conditions to be imposed, two weeks continuous operation should be adequate to show whether a structure is likely to transmit and to accumulate moisture to any serious extent. Experience to date for the walls tested indicates that a shorter time may be sufficient, consequently, for some phases of the tests much shorter periods were used.

A typical test program for one unit follows:

Fourteen days at 70F—45% humidity, and 20F—78% humidity; vapor pressure difference 0.125 lb per sq in.;

Four days at 70F—65% humidity, and 20F—78% humidity; vapor pressure difference 0.20 lb per sq in.;

Three days at 70F—45% humidity, and 20F—78% humidity; vapor pressure difference 0.125 lb per sq in. Sixty-six, 1/16-in. holes through inner vapor barrier in 324 sq ft of surfaces;

Five days at 70F—45% humidity, and 20F—78% humidity; vapor pressure difference 0.125 lb per sq in. One, 7/32-in. hole and sixty-five, 3/16-in. holes through inner vapor barrier;

Two days at 70F—45% humidity, and 20F—78% humidity; vapor pressure difference 0.125 lb per sq in. One, 1¼-in. hole and sixty-five 13/32-in. holes through inner vapor barrier.

During the progress of a test, periodic readings were taken of temperatures at various points, the humidity in various spaces including voids inside walls, ceilings, etc., the power required to maintain the desired 70F temperature, and the daily evaporation of water to maintain the required humidity. Daily inspection of the interior of the house showed where surface condensation was taking place because of high heat transfer, for example over through-metal members such as window frames or girders. Access doors or panels were also provided through the outside metal

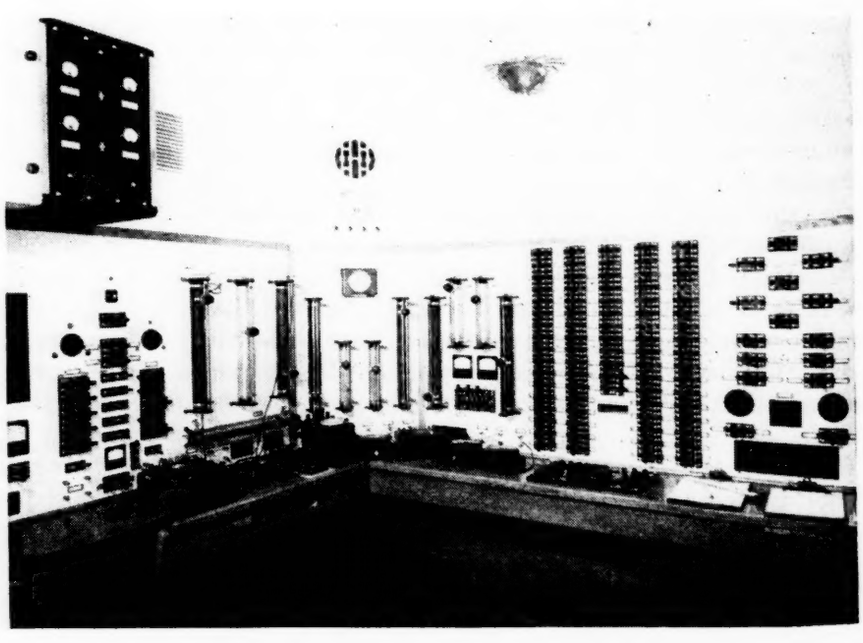


Fig. 2. Instrument control panel in Climatometer.

Table 1—Constructions Tested and Some Temperatures Recorded

Unit No.	Construction	Blanket Insulation Thickness, Inches	Ventilation*	Temperature Readings (Air inside test house, 71F; Air of Climatometer, 20F) Inside Surface	Outside Surface	Inside Surface Joint	Outside Surface Joint	Vapor Barrier	Condensation Present
	Floors								
1	Linoleum on sheet metal, ¼-in. pressed wood strip on 4-in. metal joist for insulation, sheet metal	2	Vented	65.5	280	60.5		Sheet metal	No
2	Same as No. 1	4	Vented	66.5	26.0			Sheet metal	No
3	Finish wood floor, paper, subfloor, 4-in. metal joists, sheet metal	1	No					On warm side of blanket	No
	Walls								
4	Wall board (3/16-in.) on sheet metal, ½-in. felt insulating strip on 4-in. metal studs, sheet metal	2	Air wash, 0.4 sq in. per linear ft bottom and top	63.5	23.0	61.0		Sheet metal	No
5	Same as No. 4	4	Same as No. 4	65.0	26.0	61.0		Sheet metal	No
6	Galvanized steel sheets, wood nailing strip, 4-in. steel studs, galvanized steel sheets	1	Air wash, 0.4 sq in. per linear ft bottom and top	63.1	25.6	58.1	28.8	On warm side of blanket	No
7	Aluminum sheets, wood nailing strips, 4-in. aluminum studs, aluminum sheets	1	Same as No. 6	49.5	27.8	47.0	30.9	Same as No. 6	No
8	Wall paper on ⅜-in. gypsum board, wood nailing strips, 4-in. aluminum studs, aluminum sheets	1	Same as No. 6	66.8	23.4	59.6	26.3	Same as No. 6	Considerable
9	Painted plaster on metal lath, wood nailing strips, 4-in. aluminum studs, aluminum sheets	1	Same as No. 6	65.6	25.7	54.8	32.2	Same as No. 6	Some
10	Painted plaster on ⅜-in. gypsum board, wood nailing strips, 4-in. alum. studs, alum. sheets	1	Same as No. 6	62.2	25.1	57.5	27.8	Same as No. 6	No
	Roofs								
11	Flat; 3/16-in. wallboard on sheet metal, ½-in. felt insul. strip on 6-in. metal joists, sheet metal deck with asphalt roofing mopped on	4	Vented, 4½ sq in. per ft at eaves	67.5	25.5	65.0			
12	Flat; galvanized steel sheets, wood nailing strips, 6-in. steel joists, ½-in. plywood, with asphalt roofing mopped on, built up roof	2	Air wash, 1.5 sq in. per ft at eaves plus 4 in. dia. by 12 in. stack at center	63.0	25.4				
13	4-in. in 12-in. pitched roof; wood sheathing nailed direct to 16 gauge steel joists 24-in. o.c. and asphalt shingles. Ceiling of aluminum sheets, 4-in. aluminum joists with wood nailer strips	2	Air wash, 2 louvres each 9 sq in. free area 1/390th of 49 sq ft projected roof area	65.2	(Air in attic space, 37.7F)				

Windows

Unit No. 14 Fixed—storm window and ½-in. rigid board insulation added

Unit No. 15 Casement—storm window and ½-in. rigid board insulation added

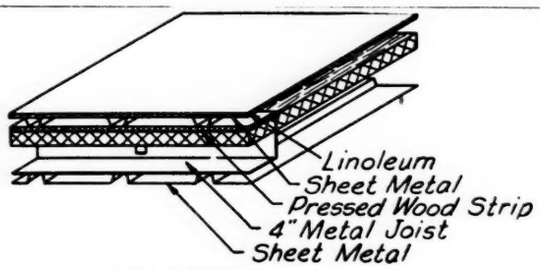
Unit No. 16 Double hung — storm window added

Doors

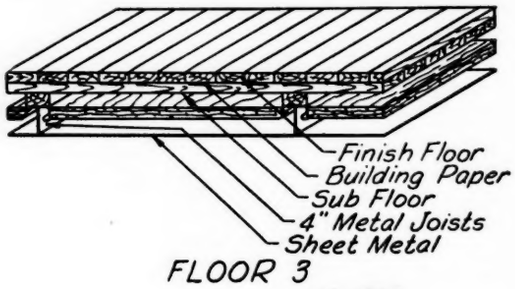
Unit No. 17 Storm door added—½-in. rigid board insulation added

Unit No. 18 Glass and wood panels—½-in. rigid board insulation added, nailed over whole door

*Air wash—open for free, through circulation of air to carry off moisture to atmosphere.
Vented—depends on diffusion to carry off moisture to atmosphere.



FLOOR 1



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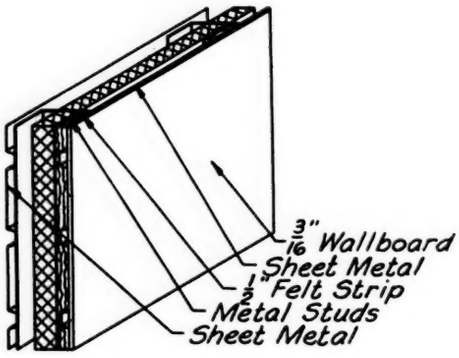

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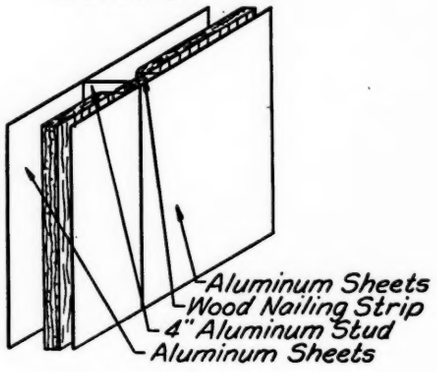
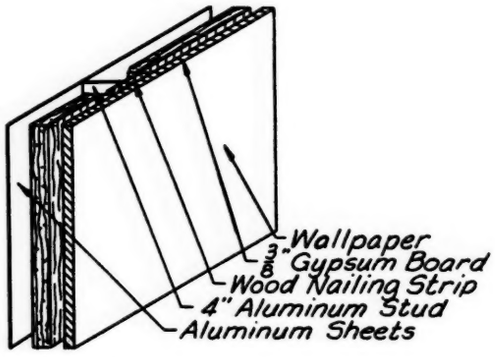


WALL 7



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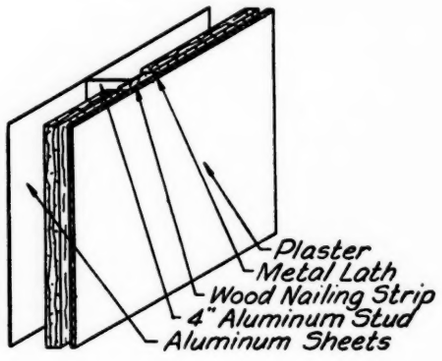

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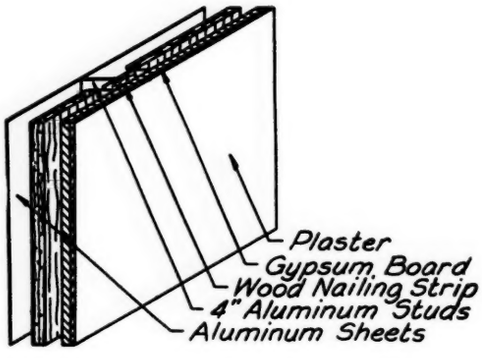
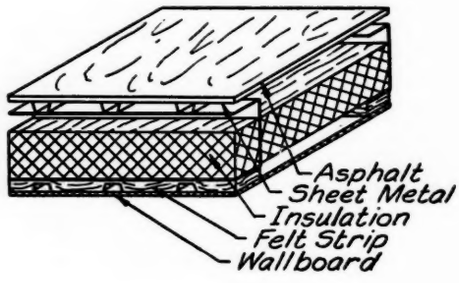
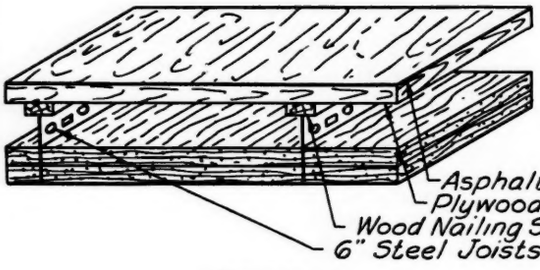


WALL 10



ROOF 11



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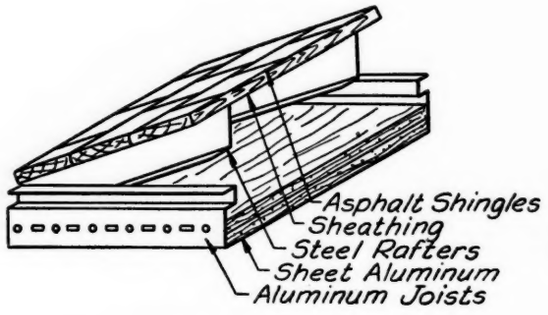

ROOF 13

Fig. 3. Sketches of structural types tested.

surfaces to permit visual examination of the interior of the wall from time to time to see whether moisture or frost was accumulating. With a temperature of 20F in the Climatometer all of the outer metal surfaces were well below 32F as may be seen from the typical temperature readings in Table 1.

Results of Tests

Although the rate of evaporation for humidification followed a well defined pattern, it cannot be used directly as a measure of vapor transmission of the structure. Leakage around the door and windows and condensation on interior surfaces, where temperatures were below the dew point, as well as absorption by hygroscopic materials in the structures, accounted for some of the loss. Similarly the power required to heat the house cannot be used to measure the thermal resistance of the structure. However, for constant temperature and humidity conditions there was an apparent slight increase in power consumption with increased evaporation.

All three floor sections had effective vapor barriers. Floors No. 1 and 2 had sheet metal flooring under the linoleum floor covering. Floor No. 3 had building paper between finish and sub-flooring and a vapor barrier on the warm side of the blanket insulation. There was no indication of moisture accumulation under any conditions.

Walls No. 4, 5, 6, 7 and 10 proved satisfactory with the ventilation specified in Table 1. Wall No. 9 showed some condensation on the access doors, while No. 8 showed serious moisture accumulation. The one-inch blanket insulation used in walls No. 6, 7, 8, 9 and 10 had a vapor barrier (mean vapor transmission = 0.59 grains per sq ft per hr per lb per sq in.) on the warm side stapled to the studs. Walls No. 4 and 5 depended entirely on the inner sheet metal surface for a vapor barrier.

To investigate the need for venting and to show the relationship between the rate of vapor transmission and the amount of venting as a controlling factor in moisture accumulation, the vents on walls No. 6, 7 and 10 were sealed. The humidity records for these walls show that within a short time the dew point increased from 17F to approximately 30F. This indicates that without proper ventilation condensation would occur since the temperature of the outer walls was approximately 25F. When these walls were subsequently opened for inspection, condensation was found. At the same time the ventilation of walls No. 8 and 9, in which moisture was accumulating, was increased from 0.4 sq in. per foot of wall at top and bottom to 4.4 sq in. corresponding to that for walls No. 4 and 5. The dew point in wall No. 9, painted plaster on metal lath, dropped from 25F to 17F. In wall No. 8, wall paper on wall board, the dew point dropped from 30F to 15F. It was evident that for the test conditions, 0.125 lb per sq in. vapor pressure difference, the ventilation was now adequate and possibly more than necessary. Consequently, the vent area was progressively reduced on wall No. 8. With 2.4 sq in. per linear foot of wall the dew point rose to 17F; with 1.4 sq in. the dew point was 20F, still on the safe side; and, finally, with 0.9 sq in. the dew point rose to 24F, high enough to permit condensation under the test condition. Some of these results are shown graphically in Fig. 4.

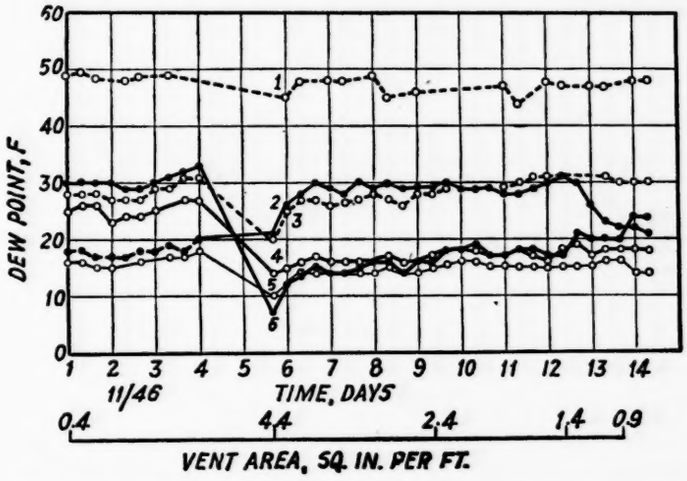

Fig. 4. Dew point variation with changes in vent area; (1) inside house, (2) galvanized wall, (3) attic, (4) plaster wall, (5) Climatometer, (6) wallboard and wallpaper wall.

The construction used for walls No. 4 and 5 and for roof No. 1 gave an exceptionally tight metal vapor barrier. This, combined with the generous vent area, precluded any moisture accumulation in the walls. To determine the effect of perforations of the inner vapor barrier on moisture transfer, tests were run with progressively larger holes arranged in groups opposite the humidity sensing elements. The first test was made with a total of 66 holes 1/16 in. diameter arranged in groups of one, five, and ten adjacent to moisture measuring cells. There were 16 holes in the ceiling, 10 in the floor and 40 in the walls. Three days operation, with a vapor pressure difference of 0.125 lb per sq in. gave no indication of any humidity increase in the exterior structure. Ten of the 1/16-in. holes in the ceiling were caulked and replaced by one 7/32-in. hole having a slightly greater area. All other holes were enlarged to 3/16-in. diameter. Five days operation did not show any moisture accumulation. The hole in the ceiling was finally enlarged to 1¼-in. diameter and all other holes to 13/32-in. diameter. After two days operation with a vapor pressure difference of 0.125 lb per sq in. the humidity in the roof showed a definite increase. In this house the vents at the top of the walls opened into the roof space which was vented only at the eaves; this permitted the moisture entering the walls to pass into the roof space where it tended to accumulate. The temperature in the Climatometer was then lowered to 0F to give a vapor pressure difference of 0.155 lb per sq in. for two days. At the conclusion of this test, inspection showed considerable frost and ice on the cold roof plates, with some condensation on the roof girders and in the ceiling insulation. A sample of insulation from the vicinity of the 1¼-in. hole in the ceiling lost about 23% of its dry weight when dried 48 hours.

Some condensation was found at the top of wall No. 5 with 4 in. of insulation; there was none at the bottom of the wall. Wall No. 4 with 2 in. of insulation and unobstructed air wash showed a light coating of

frost near the top at one place opposite the five 13/32-in. holes through the inner wall. No condensation was found at any other point in this wall and the humidity cells indicated that it was still comparatively safe from condensation at the 0F ambient and 0.155 lb per sq in. vapor pressure difference.

Occasional reference has already been made to conditions in the ceilings or roofs. In general they performed satisfactorily except where side walls with poor vapor barriers were vented to the ceiling space. This was particularly noticeable with the pitched roof No. 13 where wall No. 8, wall paper on gypsum board, was vented to the attic space. Although there were two louvers each with a free area of 9 sq in., one in each gable, there was some condensation in this space. In roof No. 1 the joint between adjacent sections was caulked with a sealing compound. This developed a few weak spots during the tests which permitted some moisture to condense on the cold roof joists.

Everyone is familiar with condensation on windows when the inside humidity is high and there is a drop in the outdoor temperature. Precisely the same condition results if there is insufficient insulation in the wall or if there is a through metal path offering inadequate thermal resistance. Walls No. 6, 7, 8, 9 and 10 showed some surface condensation, usually near the bottom, at the 70F and 20F runs, and serious condensation at 70F and 0F. The effect of adding insulation between the base channel and the bottom of the wall panels of wall No. 7 on surface condensation was investigated for four materials. Hair felt, ½ in. thick; cork, ⅛ in. thick; insulation blanket, 1 in. thick; and nine layers building paper, were used for different panels. The felt and the insulation blanket were materially compressed when the panels and base board were put into place. With conditions of 70F and 38% R.H. in the house and 0F ambient (0.125 lb per sq in. vapor pressure difference.) The following temperatures were observed near the base board at the centers of the panels:

Hair felt	49.7F
Cork	46.2F
Insulation blanket	50.0F
Building paper	40.5F

With a dew point of 43F in the house there was condensation on the panel with paper over the base channel, extending up six inches at the center. The centers of the other panels were dry. However, over the metal studs the temperature was below the dew point in some places causing local condensation. In wall No. 8, the wall board was fastened to the nailing strips with nails that went through to the metal studs. This made the nail heads local cold spots that caused condensation to wet the wall paper at these points.

Condensation on inside wall surfaces of the test houses indicated points of high heat transfer, due either to inadequate or to improperly applied insulation or to through metal-to-metal contact. Such observations are interesting because they show in a convincing manner weak spots that need attention. For quantitative results, however, guarded hot-box tests on full-scale test panels are desirable. Such panels, each 67½ in. × 67½ in., were provided for many of the constructions used.

The results of the guarded hot box tests are summarized in Table 2. The conductance values are test results. The transmittance value was calculated by combining the test conductance with an inside surface coefficient of 1.65 and an outside coefficient of 6.00.

Table 2 — Results of Guarded Box Tests

	Mean Temperature Deg. F	Conductance Btu per sq ft per hr per F	Transmittance Btu per sq ft per hr per F
Wall No. 4	45	0.23	0.19
Wall No. 5	45	0.15	0.14
Wall No. 7	35	0.33	0.26
Wall No. 7a (2" insulation)	35	0.24	0.20
Wall No. 8	35	0.31	0.25
Wall No. 9	35	0.44	0.33
Roof No. 12	35	0.21	0.18*

*Tested in vertical position.

The high transmittance of wall No. 9, plaster on expanded metal lath, was surprising until it was noted that the plaster key was in contact with the metal stud. This resulted in low thermal resistance and high heat flow. The temperature of this wall in the test house was appreciably lower over the studs than between them. This difference in temperature could not only be felt readily by passing the hand over the wall, but was indicated by condensation on the plaster at certain points. The same was true also for walls No. 6, 7, 8 and 10, although it was perhaps least noticeable in wall No. 8.

Walls No. 6 to 10 inclusive have too low a surface temperature for comfort during cold weather. It was also noted that where blanket insulation is used between the studs workmen do not always appreciate the need for careful installation. This seems particularly true at the top and bottom, where no effort is made to have the material the proper length and to seal it effectively, permitting both heat and moisture leakage.

Summary

A study of the problem of moisture control in prefabricated and conventional structures is being conducted in cooperation with the National Housing Agency. The results of several tests are incorporated in this paper. Emphasis is placed on the need for a good vapor barrier properly applied. Data are also included for cases where the exterior surface is a metal sheet. By providing adequate wall ventilation the short comings of a vapor barrier and the difficulty in its installation may be overcome. This ventilation had only a slight effect on the heat transmission. When the inner barrier was punctured with a limited number of small holes, such as used for mounting fixtures, it was found that adequate ventilation was necessary to prevent the accumulation of moisture in the wall.

Air Recirculation from Exhaust Systems

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A discussion which presents both sides regarding the question of recirculation of exhaust in a dust control system. Several factors favorable to this practice are presented in detail, as well as some of the points that affect air recirculation.

THE feasibility of cleaned air return from dust control systems being used for industrial exhaust ventilation has been debated for a number of years. The introduction or modernizing of state codes, and the results of investigations and surveys published in recent months, has brought added attention and renewed discussion of the subject.

If factors of a practical nature were eliminated, there would be no need for further consideration of the problem. The industrial hygienist, the plant engineer, and the dust collector manufacturer would like to see all cleaned air discharged to the atmosphere. This practice would eliminate concern about the possible contamination of workroom air from recirculation, would in many cases decrease the maintenance and attention that the dust collecting system will require, and in many installations it would permit the installation of less expensive collectors for the dust removal function. The dust collector manufacturer would require considerably less information on the proposed installation before making his recommendations for equipment to be installed.

Disadvantages of Recirculation

There are many valid arguments in favor of the discharge of all exhaust systems to atmosphere regardless of the material handled or the concentration. Three are listed.

Maintenance. Dust collectors and exhaust systems seldom receive the attention and the periodic inspection and maintenance that they require. Not being an essential cog in the production of the plant product, they are too frequently installed and forgotten until a breakdown of the dust collector results due to some complete plugging of the system, reduction in volume because of belt splippage, or wear of the exhauster. This condition implies that an exhaust system with its dust collector can operate at reduced efficiency for an indefinite period without correction of the difficulty.

Maintained Dust Separation Efficiency. Where air is recirculated from a dust collector, the efficiency of the collector must be such that the dust concentration in the cleaned air will be below specified limits for the material collected. Separation efficiency of a collector may be impaired by wear, improper operation or maintenance. Dust loading may be increased by change in production rate, by the addition of other exhaust points or by increase in the rate of dust generation from variation in raw material or method of processing. Increase of dust concentration, particularly for toxic dusts, can therefore occur that may exceed acceptable limits without visible escapement from the dust collector. Periodic routine sampling of the discharged air to prevent this occurence requires personnel with specialized training and experience. Such men are seldom avialable in the average plant.

Proper Evaluation. Recirculation from dust collection equipment can be used as a selling point without full evaluation of the disadvantages. Against the savings in heat by the return of cleaned air to the workroom, must be weighed factors such as possible added equipment cost, horsepower consumption, equipment maintenance, toxicity of dust, buildup of odor, temperature or humidity conditions within the workroom.

Need for Recirculation

Unfortunately, the question of recirculation of cleaned air from exhaust systems cannot be closed so quickly due to many practical difficulties that will be encountered. These difficulties normally fall under one of the three following groups:

Economy. It must be noted that the quantity of air moved by exhaust ventilation has increased markedly during the last few years, and that the trend toward the use of such systems is still increasing. Continual addition to the knowledge of the physiological effects of materials in dust, fume, or vapor form is being contributed by numerous research groups; standards for acceptable working conditions have been continually raised as regards plant cleanliness and freedom of workroom air from dust, fumes, and vapors.

The heat loss during the heating season with the discharge of heated air to the atmosphere is an expensive item in most sections of this country. The exhaust of 1000 cfm during a heating season of seven months of 200 hours per month with an average temperature difference of 30F means the waste of 56,000,000 Btu per season or from 2.5 to 4 tons of coal, dependent on boiler plant efficiency. When it is recognized that exhaust volumes in many industrial build-

ings are of the magnitude of 50,000 to 200,000 cfm or higher, the question of recirculation takes on a real dollar and cents significance.

The problem does not stop in many plants with the question of added fuel consumption. Even in plants of recent design, use of exhaust ventilation has increased so greatly that present heating systems and boiler plant capacity will not meet the heat load requirements. Unless recirculation is feasible, expensive additions to boiler capacity and extensive alterations to heat supply system is mandatory.

The decision of a machine tool manufacturer to collect the dust from portable grinding of machine tool parts increased the exhaust ventilation in the finishing room from 4,000 cfm to 24,000 cfm with room dimensions of only 75 ft × 30 ft. In such instances, where large exhaust volumes are required to remove low concentrations of non-toxic dusts, it is questionable if the expenditure for improved working conditions could be justified if the cleaned air were not returned to the workroom during the heating season.

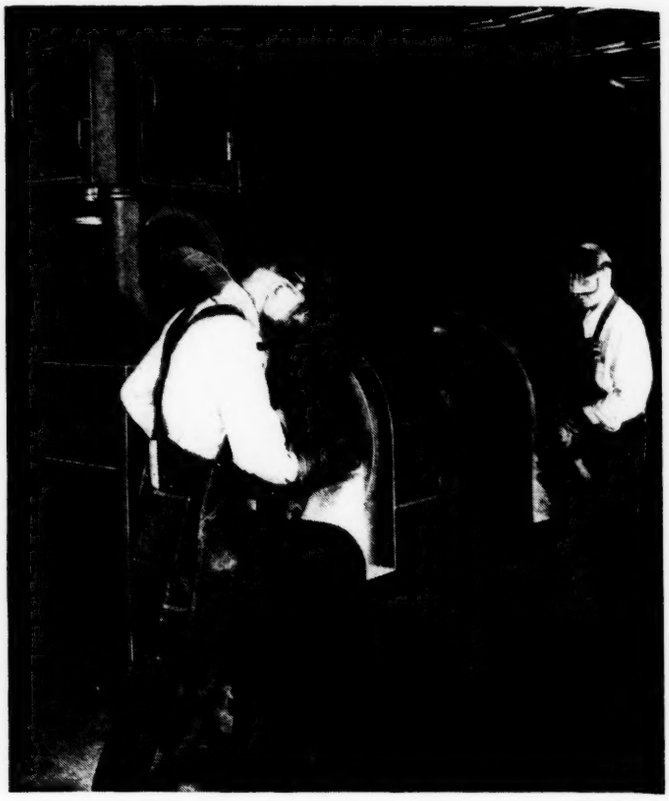
When an airplane propeller manufacturer provided exhaust ventilation for the portable grinding of propeller blades, the exhaust volume increased 250,000 cfm. This volume was several times the volume of air exhausted from all other processes in that plant, and would have produced an acute heating problem if the cleaned air had not been returned.

Exhaust ventilation for the collection of lint fly from such textile operations as cards, spinning frames and looms will involve very large volumes due to the number of machines in this category operated per unit of floor area. The practicability of improved working conditions in such plants may be entirely dependent on the return of cleaned air to the workroom.

While it is recognized that the recirculation of air containing toxic dusts, fumes or vapors is not recommended except in unusual circumstances, the magnitude of exhaust systems handling relatively non-toxic or so called nuisance dusts may justify their consideration in a separate category when the problem of heat loss is evaluated. In many cases discharge of such systems to the atmosphere during the summer months is entirely practical and the makeup air provides added general ventilation during that period.

As the trend continues toward air conditioning plants, the need for return of cleaned air, wherever practical, will be further emphasized. In such cases, each 1,000 cfm exhausted will require an additional 2 to 4 tons refrigeration capacity dependent on wet and dry bulb outside temperatures of the locality and required conditions within the conditioned area. The exhaust of relatively large volumes can require the supply of such a large volume of outside air to the conditioning system that the outside air load will be very high in proportion to the recirculated load. Such a set of conditions impose additional problems on the thermostatic control system and on the selection of air handling unit and refrigerating system, invariably again increasing the conditioning plant cost. Cases can be visualized where the added load due to exhaust systems discharged to the atmosphere, would make the cost of air conditioning prohibitive.

Flexibility. Where recirculation of cleaned air is practical, its use by a plant engineer can be prompted by the ease of relocating collection equipment with change in department layout. Advantages of such flexibility was repeatedly demonstrated at many plants during conversion to war work, change from one war contract to another, and during reconversion to peace time production.



Centrifugal dust collector with viscous aftercleaner, made by American Air Filter, cleans and recirculates air from grinder.

The automotive production line, where every machine tool may be relocated once or more each year, illustrates the need for flexible exhaust systems and collection equipment in meeting changes in plant layout.

No Practical Means of Discharging Air to Atmosphere. There are a number of applications of dust control exhaust systems where it is either impossible or decidedly difficult and expensive to discharge exhaust air to the atmosphere. Applications in this group include:

PORTABLE SYSTEMS. Dust frequently is produced intermittently at a number of locations or by traveling mechanisms. Small dust collector units are moved about in tool rooms where occasional dust producing operations are involved. Masonry saws and their dust collectors may be moved from one location to another as required for relining furnace shells or roofs. Dust collectors will be attached to traveling scales and measuring hoppers moving from bin to bin. Applications in this group practically necessitate the use of compact collector assemblies, cleaning the exhaust air, and returning the cleaned air to the room.

SYSTEMS REMOTE FROM ATMOSPHERE. Situations are encountered in many plants where the ability to run a discharge duct to the atmosphere may involve duct lengths of 100 ft or more. Where the volume ex-

hausted is small, duct sizes are small also, making the resistance loss, cost of installation, and the horsepower required very expensive for the volume of air handled. In plants with overhead cranes and large bays, running a discharge duct from the center of a bay is a distinct problem unless expensive underground pipe trenches are employed.

Factors Affecting Recirculation

This discussion has shown some reasons why recirculation of air from exhaust systems cannot be dismissed arbitrarily. A decision for any installation can only be made after evaluating the following items:

Contaminant Handled. Except in those special cases where exhaust air can be discharged to atmosphere only with extreme difficulty, recirculation of air containing toxic materials whether dust, fumes or vapors, should not be attempted, regardless of efficiency of collection system. Possibilities of reduction of collector efficiency due to wear, incorrect operation, or lack of maintenance makes such recirculation a possible source of hazard unless cleaned air is checked at very frequent intervals using accepted sampling methods in the hands of an experienced investigator.

Non-toxic or Nuisance Dusts. For the large group of materials in this category, items to be evaluated include:

HEAT LOSS, as compared to possible added collection equipment cost or maintenance.

CAPACITY in existing heating system to supply heated makeup air to compensate for volume exhausted.

EFFICIENCY OF DUST COLLECTOR necessary to permit recirculation. As indicated by the wide variation in opinions recorded in the literature and codes, it is difficult to arrive at a recommendation that covers the range of probable applications. Recommended cleanliness of recirculated air will depend on the size of the exhaust volume, the cubic content of the room involved, the existance of other exhaust systems in the immediate area and the material collected. An exhaust volume of 1000 cfm will discharge one tenth the dust to a room when compared to a volume of 10,000 cfm assuming the same concentration, material, and collector efficiency. An exhaust volume of 1000 cfm containing a specified dust count would raise the dust count in a small workroom to a greater degree than in a room with several times its volume.

Equilibrium dust count level in a workroom will be at a lower level where exhaust systems discharging to the atmosphere from other operations are located in the same room because dilution is provided by the makeup air supply. These variations explain the range in acceptable standards suggested by different groups.

To require a cleanliness of not more than 3 million parts per cubic foot above ambient for any recirculating system plus 100 cu ft of room air for each cubic foot exhausted, as suggested in a recent study, may be desirable for free silica dusts and other toxic materials, but it seems unnecessarily restrictive for the exhaust of metal working, woodworking, package filling or similar operations where dust is non-toxic and basically a nuisance problem. Such a regulation would permit the return of 1000 cfm for a unit collector attached to not more than one 2-wheel metal grinding stand or a wood sander in an area of 100,000 cu ft or a room 250 ft $\times$ 40 ft $\times$ 10 ft.

Summary

Recirculation from exhaust systems should be discouraged rather than encouraged for most applications. However, there is a distinct need for careful evaluation of all factors before blanket recommendations are formulated to cover the range of exhaust system applications.

A recent survey of health department attitudes toward recirculation showed widely divergent views on this subject. While most states are reluctant to permit return of air exhausting toxic materials, many have recognized the practical considerations of air return and do permit recirculation under certain conditions, where non-toxic materials are involved.

Opinions of plant engineers and consulting engineers will also differ widely with the relative weight they attach to the various factors involved.

Alarm Thermostat for Frozen Food Cabinets

A new device, called an alarm thermostat has been developed by the General Electric Co. for protection of frozen food cabinets and to give the owner warning in ample time to correct the trouble before the cabinet begins defrosting. It is designed to eliminate costly food losses in commercial frozen food cabinets, chill rooms of big packing plants and markets, refrigerated warehouses and even household units.

The thermostat is wired to a visual signal system, usually a light or an electric alarm clock, and gives an immediate signal in case of power failure. A safe, delayed signal is given if the failure is in the freezing unit. It operates simply, incorporating a contact made at the end of a piece of temperature sensitive bimetal. This contact will remain closed at low temperature, but opens when the temperature rises, giving a warning signal. Opening temperature can be set at any desired level, and as it takes approximately 36 hours for a freezing unit to defrost, ample warning is given to remove the contents, or to repair the break.

Heat Removal from Electrical Apparatus

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Ventilation requirements for electrical apparatus have always been concerned with ambient temperature; however, insofar as standardization is concerned, standards for temperature rise of motors and transformers are based on the total temperature (ambient temperature plus temperature rise) to which the insulation is subjected. The rise is separately given as an indication of whether the load is being kept within limits.

With a number of limitations, electrical apparatus can be operated in ambient temperatures higher than standard as long as the total temperature to which the insulation is subjected does not exceed the temperature limits on which the standards are based. On the other hand, it is no doubt unwise to proceed solely on that basis without obtaining the opinion of the manufacturer of the apparatus after he has had the opportunity to give due consideration to all the various factors which may be involved.

With the foregoing precautions in mind, the accompanying article does show the possibilities of reducing the ventilation and filtration requirements for electrical apparatus in certain cases. Electrical codes are concerned solely with the protection of electrical apparatus and give no thought as to how such apparatus may be cooled with a minimum of air.

THE ventilation (excess heat removal) of transformer vaults, motors and other electrical apparatus is occasionally annoying to the ventilating engineer because he encounters the problem so infrequently that it is difficult to remember how it was handled previously. Further, the data on the subject are not assembled, nor are they available in a convenient and easily digested form. So the day finally came when the writer made up his mind that he would take time off long enough to study the strange wording of codes which of necessity must be legal, to assemble the necessary data, and, incidentally, to learn the background of the subject with a view to improvement of the ventilation method.

At the outset, one is handicapped to a certain degree by the considerable quantity of air which must be supplied to the electrical space, since the outdoor air in the hottest months must in most cases enter at 95F or higher, and leave (by NEMA standards) at 104F (40C). This gives a temperature rise of only 9F. The air required, therefore, per minute is

$$\frac{\text{2545 Btu equiv. of 1 hp. hr}}{60} \div (.018 \times 9F) =$$

262 cfm per hp input

$$\frac{\text{3413 Btu equiv. of 1 kw-hr}}{60} \div (.018 \times 9F) =$$

350 cfm per kw. input

$$\frac{3413 \times 2\% \text{ (transformer loss)}}{60} \div (.018 \times 9F) =$$

7 cfm per kva transformer capacity*

where .018 is the specific heat of air. These quantities should be increased by the amount required to offset duct leakage and to remove the heat of lights and sun, or any other heat given. They may be decreased where there are a considerable number of motors operating under intermittent schedules.

It is true that a kilowatt† and a kilowatt-volt-ampere are two different things and not always equal in their thermal equivalents; they are equivalent, however, in heat terms when the power factor is unity. The power factor may be 1.0, or it may be 0.8 (usually no one knows what it is), but if taken at 1.0 the designing is on the safe side for heat removal and avoiding a troublesome bit of unnecessary mathematics and technical fact finding.

In the case of motors all of the electrical input is converted to heat—entirely within the space when the motor and its load are both in that same space. To illustrate, a 20-hp motor with an efficiency of 85% would have an input of $\frac{20}{.85}$ or 23.5 hp., which, from foregoing data, would require $23.5 \times 262 = 6157$ cfm of ventilation air.

Ventilation requirements for electrical apparatus (as based on the usual limitations of air entering at 95F and leaving at 104F) become very large in number of air changes within the space, as previously pointed out. In the case of transformers while the maximum ambient temperature is limited to 104F, the average ambient temperature is also limited and to a much lower temperature for it must not be over 86F (30C) during any 24-hr period (see Table 1). Because of these various limitations, Table 1 should be of interest, for it shows how the ventilation requirements can be greatly reduced in some cases, or at least met in other cases where the climate or operating environment is very hot; it also shows just what are the temperature or ventilation requirements for electrical apparatus.

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*The transformer loss may be less than 2%, but this is a safe figure. The heat loss is due to (1) eddy current and hysteresis losses in the core and (2) current resistance of copper windings. (1) is practically independent of load on the transformer and (2) varies approximately as the square of the load current.

†Kw = Kva x Power Factor. Kva = $\frac{\text{Volts x Amperes}}{1000}$ for single phase current. For 3-phase, multiply this by 1.73.

Table 1—Temperature Limitations of Electrical Apparatus As They Affect Ventilation Requirements

	Type of Equipment	Column Number 1	2	3	4	5	6	7
		Class of Insulation	Temperature, C (As measured by thermometer—not resistance—for altitudes not over 3300 ft above sea level)					
			Ambient	Rise	Amb.+ Rise (Col. 2 + Col. 3)	Hot Spots[f]	Service Factor[g]	Total (Sum of Col. 4, 5, 6)
A	Motor, Open Type	A	40	40	80	15	10	105
B	Motor, Open Type	A	50[c]	40	90	15	—	105
C	Motor, Open Type	A	40 +	40 —	90	15	—	105
D	Motor, Open Type	B	40	75	115	10	—	125
E	Motor, Open Type	B	40 +	75 —	110	15	—	125
F	Motor, Totally Enclosed[a]	A	40	55	95	10	—	105
G	Motor, Totally Enclosed[a]	A	40 +	55 —	95	10	—	105
H	Motor, Totally Enclosed[a]	B	40	75	115	10	—	125
I	Motor, Totally Enclosed[a]	B	40 +	75 —	115	10	—	125
J	Motor, Drip and Splash Proof[b]	A	40	50	90	15	—	105
K	Motor, Drip and Splash Proof[b]	B	40	70	110	15	—	125
L	Motor, Totally Encl., Drip-Splash Proof[a,b]	O	40	35	75	15	—	90
M	Transformer	A	40[d]	55	95	10	—	105
N	Transformer	B	40[d]	80	120	10	—	130
O	Transformer with air blast	A	40[d]	60	100	10	—	110
P	Transformer	A	25[e]	—	—	—	—	—

[a] "Totally enclosed" includes fan-cooled, explosion-proof, waterproof, dust-tight, submersible, and dust-explosion-proof types.
[b] "Drip and splash proof" includes protected, semi-protected, drip-proof, splash-proof and drip-proof-protected types.
[c] Where the application is known and there will be no overload.
[d] Maximum. When cooling medium is air, not over 30C average temperature of windings during any 24-hr. period.
[e] When cooling medium is water, not over 25C average temperature of ingoing cooling water during any 24-hour period.
[f] Assumed to be that much hotter than average temperature of windings.
[g] 200 hp and smaller.

How Ventilation Requirements Can be Reduced

Suppose the location under consideration is one where the outdoor or supply air is well over 95F, say 104F; how then, can this air be used for cooling or heat removal when the ambient (surrounding) temperature of the electrical equipment is limited by NEMA standards to not over 104F (40C)? The answer is that this limitation of 104F can be raised in certain cases, providing the ambient plus the temperature rise of the equipment does not exceed those as given in Col. 4 of Table 1 for lines C, E, G and I. In other words, the ambient temperature (Col. 2) can be increased in the given cases when motors with less temperature rise are selected.

As another example, insulation known as Class B can be substituted at an increase of about 15% in cost over that for the usual Class A, in which case the quantity of ventilation air can be reduced to one fifth in the case of motors (See Col. 7, line *A* versus line *D*, *F* versus *H*, or *J* versus *K*), or to one sixth in the case of transformers (line *M* compared to line *N*).

In general, the service condition to which open type general purpose motors are subjected are uncontrolled and not subject to exact determination, so that the basis of rating chosen provides a factor of safety of 10C in temperature rise at 100% loading (see line A, Col. 6).

Where the application is known and there will be no overload, this service factor of 100C (18F) can be omitted and added to the ambient (see Line B) in the case of open motors with Class A insulation. This, of course, reduces the air requirements for ventilation. On the other hand, should the horsepower rating of the motor be increased by taking advantage of the service factor, then the usual temperature guarantees do not hold.

Example: Assume that a machine to be driven requires 44 brake horsepower, minimum. Instead of using a 45-hp motor, one of 40 hp may be safely used (the service factor permits a loading of 1.10 times 40 or 44 hp), provided the starting torque and pullout torque of the 40-hp motor are adequate and the rated voltage and frequency are maintained. In such a case, the 40-hp motor should not be operated in an ambient temperature above 40C.

Still another point is that in many cases the ventilation air is rather carelessly introduced, especially so since the usual application is in a space briefly or seldom occupied by anyone. In such cases much of the air movement is usually wasted, merely by-passing the

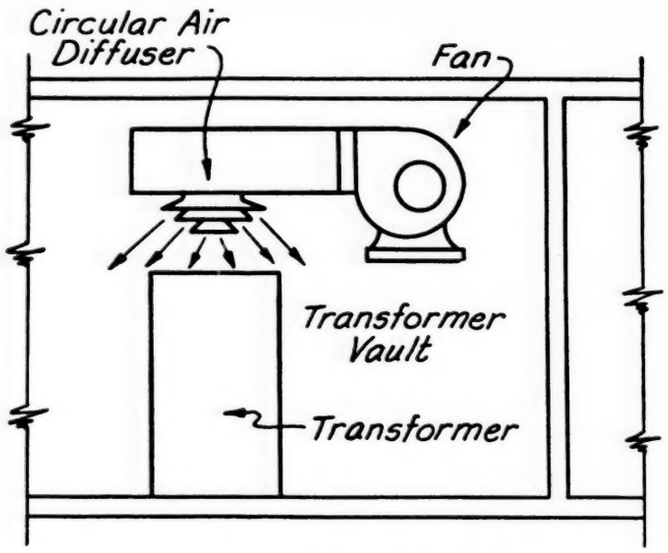

Fig. 1. Method of cooling a transformer.

hot surfaces of the electrical equipment and finally venting from the space without any appreciable rise in temperature of the air as exhausted. As a result, the ambient or air temperature at some of the equipment rises beyond limitations, so that to keep within these limitations additional air must be introduced by the amount which by-passes any part of the equipment and therefore provides no over all cooling effect. It does not suffice to cool only a portion of any piece of equipment, since there are limitations on the hottest spot under normal continuous rated conditions (see Col. 5). The important thing to remember is that it is not the apparatus room which should be ventilated, except as required to provide workable conditions for occasional workmen on the apparatus, but rather the apparatus itself. This fact is often overlooked.

Ventilation of Transformer Vaults

In connection with the ventilation of transformer vaults by natural means, the National Electrical Code specifies that at least 3 sq in. of ventilating opening shall be provided for each 1 kva of transformer capacity, and in no case less than 1 sq ft. If this rule is checked against the formula for natural ventilation as given in the *ASHVE Guide*, the quantity of air supplied will be found far from adequate; furthermore, the rule takes no account of other heat gains, or the fact that ventilation by exhaust is not directional. Regardless of how the ventilating openings are placed, not all of the air supplied will pass over the apparatus.

The rule further states that where openings can not be connected to chimneys or flues, or directly to the outside air, they shall be provided with automatic fire dampers made of metal of not less than No. 10 U. S. Standard Gauge. Openings to the outside air should be located as far away as practicable from doors, windows and inflammable material. Such openings should also be protected by louvers or by substantial fixed metal screens with mesh not larger than ¾ in. and should be so constructed that snow or rain will not reach wiring or apparatus of other than weatherproof construction.

Fig. 1 shows a good method of introducing the air to transformer vaults through a circular air diffuser with equalizing damper so as to blow directly downward over the entire exterior sinusoidal corrugations of a transformer tank. At first thought, one might ask: Why use a type of outlet which diffuses throughout the room when we should ventilate the apparatus rather than the spaces. The answer is that a certain amount of diffusion is needed to avoid air deflections from the top of the transformer, as would otherwise result from air blasted directly downward at short range, as from a grille outlet. The type of outlet shown in Fig. 1 is one as commonly used with projection type unit heaters where the air must be discharged more or less directly downwards against the natural tendency of the heated air to rise. It is not the type which purposely diffuses the air throughout the entire space, and as a consequence, with air at lower temperatures than delivered by a unit heater, there should be no difficulty in getting the air down and in keeping it confined to the perimeter of the transformer.

Some means must also be provided for the escape of the air when raised to ambient temperature. A register at the most remote and highest level provides for this. In the case shown, there is no appreciable gravity head for venting of the heated air, and while the pressure from the supply fan will offset this and also the resistance of a liberally sized exhaust duct, a wind blowing on the exhaust hood outlet from the register could offset much of the power of the fan. For this reason, a stationary exhauster of the air jet type should be used at the vent duct outlet. Such an ejector is not adversely affected by wind direction or downdrafts, in fact, its suction may even be bettered under such conditions.

Transformer Types

Small dry type (not liquid immersed) transformers often have enough surface per unit of volume to dissipate their heat losses by natural draft, but as the size increases their volume and therefore their heat losses increase as the cube while their surface increases only as the square of the increase. Additional cooling surface must then be obtained in other ways, such as by immersing the transformer cores and coils in oil within a smooth tank around which natural or forced circulation of air takes place. Here, again, as the transformer size increases, the size of tank to provide sufficient surface by self cooling becomes greater than that necessary merely to enclose the transformer. This is what brought about the transformer tank with sinusoidal corrugations, and in time even more surface was obtained by means of external radiators or by metal tubes welded into a smooth tank.

Radiation

Additional surface obtained in this way is useful only insofar as convection is concerned, since radiation takes place only from the projected area regardless of the shape. Radiation remains as before if the emissivity of the surface is unity, as with a perfect black surface. Where the emissivity factor is less than unity,

the radiating surface is slightly less than the enveloped area, because of reradiations between corrugated surfaces.

With extremely large units, the tubes and corrugations necessary for heat dissipation become so great as to make the method too costly, so that in some cases it becomes necessary to circulate water as a cooling medium in a smooth tank containing oil. Attention, however, is required to see that the water is circulated at all times in sufficient quantity, and kept cool enough, and sometimes the cost of water is too great, or there are impurities in the water which leave incrustations on the coils.

For such conditions, forced oil cooling is sometimes used, though it is a very expensive method of cooling. With such a method, the cores and coils are immersed in oil, the cooling of which is increased mainly by oil forced through cooling coils immersed in a second tank. The oil being under pressure, water cannot escape through any possible leaks into the oil.

Air blast is also used for the forced circulation of air through the cores and coils of transformers, but due to the expense of this type of transformer it is more generally used in large municipalities where insurance requirements prohibit the use of oil.

Insulation Limits Life

The life of a transformer depends solely on the life of its insulation, hence temperature limitations for transformers are of more importance than in the case of electrical apparatus having moving parts, such as motors, where the maximum loading may be limited by factors other than temperature, such as the pull out torque. Rotating machinery is practically never required to perform under continuous operation and at the limiting temperatures, except in the case of certain services such as electrolytic.

Deterioration of insulation goes on all of the time and at most any temperature; however, limiting temperatures furnish a basis for reasonable length of life and comparative costs and performance of transformers of various type and manufacture. Such temperatures are based upon continuous operation. However, insulation can be subjected to very high temperatures if the time is short.

Effect of Color on Transformers

Some colors allow less radiation of heat from a transformer, but may compensate for this all or in part by absorbing less heat from the sun. On the other hand, the sun may be present on its surfaces for only a short time, or only a small portion of the tank may be exposed to the sun at any time and then only when the solar intensity is low. Furthermore, a light color may be of benefit on the part not exposed and of detriment to the part which is exposed. Consequently, the answer as to the proper color for the painting of tanks is a bit complicated by all of these things, as well as by the proportionate amount of heat losses dissipated by radiation and convection in each case. All in all, the effect of color on transformer tanks when located in the sun is of no moment.

Colors do not affect a transformer tank to any appreciable degree when it is located in the shade, provided it is painted with a non-metallic paint. Even when a metallic paint is used, the effect is still not great, provided that the tank has plenty of corrugations. The effect on the radiation factor may be large, but the radiating surface may be proportionately small.

Effect of Altitude on Electrical Apparatus

All self cooled electrical apparatus is affected by altitude, the amount depending on the ratio of the losses dissipated by convection to those by radiation. Air density has no effect on heat transfer by radiation, but the convection loss for a given temperature rise will vary. Transformers which depend on such features as corrugated tanks for their heat losses are therefore affected most by altitude. Altitude does not affect water cooled transformers, so long as the surface of their tanks dissipate the heat loss to only a slight extent.

Since convection depends upon the difference in weight of two columns of air, the colder (heavier) of which pushes the other up, since the air is lighter at higher altitudes due to a lesser height of column giving less compression, and since it is the weight of air moved past the electrical apparatus which removes its heat, the poundage or convection of the air that we would use at sea level conditions for the same temperature of air, must be increased at altitude inversely as the barometric pressures in order to remove the same amount of heat as required at sea level. The same is true for the pressure in the duct system as well as for the speed of the fan. The horsepower, however, increases inversely as the square of the barometric pressure.

Effect of Moisture on Electrical Apparatus

It is well to point out that electrical apparatus which stands idle for a period of time may collect moisture which might cause the insulation to break down in service. Such a condition is aggravated at the higher relative humidities.

Sometimes a totally enclosed motor is specified for a fan (as on a cooling tower) in lieu of a splash proof motor. A totally enclosed motor on an air conditioning application does not run continuously and the air inside the motor is expelled by motor heat. When the motor is turned off and begins to cool, it draws in moist air which eventually gives up its moisture in condensation. Repeating the cycle many times, it is possible to accumulate enough water to short out the windings and perhaps burn out the motor. The splash proof motor costs less and has no such pockets to collect moisture and can withstand drenching rains without damage.

Centigrade – Fahrenheit Conversions

Mistakes are often made in converting Centigrade to Fahrenheit, more particularly when adding the temperature rise to the ambient, due to the addition of 32 to both the ambient and the rise, which, of course, is adding it in twice. For example, a 40C ambient plus a 40C rise, should be converted to Fahrenheit as follows:

(9/5 × 40 ambient) + 32 + (9/5 × 40 rise) = 176F.

Converting Centigrade to Fahrenheit;

$$F = \left(\frac{212-32}{100} \times C \right) + 32; \text{ or, } F = (9/5 \times C) + 32$$

Converting Fahrenheit to Centigrade;

$$C = \frac{100}{212-32} (F - 32); \text{ or, } C = 5/9 \times (F - 32)$$

Types of Insulation

Just what is Class A insulation and why will Class B insulation allow higher ambient temperatures? NEMA standards give the answer as follows.

Insulation materials (when considered in connection with temperature limits) known as Class A are (1) cotton, silk, paper and similar organic materials when either impregnated or immersed in a liquid dielectric; (2) molded and laminated materials with cellulose filler, phenolic resins and other resins of similar properties; (3) films and sheets of cellulose acetate and other cellulose derivates of similar properties, and (4) varnishes (enamels) as applied to conductors.

Class B insulations are mica, asbestos, fiber glass and similar inorganic materials in built-up form with organic binding substances. A small proportion of Class A materials may be used for structural purposes only. The electrical and mechanical properties of the insulated winding must not be impaired by application of the temperature permitted for Class B material. The temperature endurance of different Class B assemblies varies over a considerable range, in accordance with the percentage of Class A materials employed, and the degree of dependence placed on the organic binder for maintaining the structural integrity of the insulation.

The basis of ratings, insofar as related to thermal characteristics, is that the rated load, applied continuously or for a stated period, will produce a temperature rise which when added to a standard ambient temperature, will not exceed the maximum operating temperature of the insulation.

Life Expectancy

It has been well demonstrated that the life of Class A insulation operating at a given temperature continuously over long periods will be halved with an increase of temperature between 8 and 12 C. Thus, if the insulation is assumed to have a normal life of X years at 95 C, it will have a life of $\frac{X}{2}$ years at between 103 and 107 C, and a life of $\frac{X}{4}$ years at a temperature somewhere between 111 and 119 C. Similarly, it would have a life of 2 X years at a temperature between 83 and 87 C.

In conclusion, it is well to define ambient temperature. This is the temperature of the room air which, coming into contact with the heated parts of the apparatus, carries away its heat.

Bibliography

The subject of loading transformers under various ambient temperature conditions has been given a great deal of study. The latest recommended practice on this subject is contained in a report of the AIEE Transformer Subcommittee, Pages 797 to 804, November 1945 edition of *Electrical Engineering*.

Two AIEE standards which are worthy of study in problems of the subject nature, although they do not answer the questions directly, are AIEE Standard 1 entitled "General Principles Upon which Temperature Limits are Based in the Rating of Electrical Machinery and Apparatus," and AIEE Standard 1A entitled, "Report on General Principles for Rating of Electrical Apparatus for Short-Time, Intermittent or Varying Duty."

For operation at other than standard ambient temperatures, see "American Standards for Transformers, Regulators and Reactors (including Test Code and Guides for Operation)" C 57.1, C 57.2 and C 57.3 (all of the 1942 edition).

Lead Coils Used in Anodizing Tank

An anodizing unit for small machine parts in the plant of Felt and Tarrant, Chicago, contains lead cooling coils which serve as a direct expansion chamber for a Freon gas refrigeration unit, according to *Lead*, publication of Lead Industries Association.

A coil of 1 in. lead pipe is divided into 6 sections with each inlet welded to a section of ⅜-in. copper tubing for connection to a multiple feed expansion valve which will control the flow of refrigerant. The outlet end of each coil is connected to a 3-in. lead pipe suction header closed at the bottom. Extending down inside the header to within 3 in. of the bottom is a 1½-in. lead suction pipe bushed and welded at the top of the header. This pipe is carried up over the top of the tank at which point it is welded to a steel pipe nipple for connection to the suction side of the refrigeration unit.

As the anodizing tank will contain a 20% solution of sulfuric acid, the tank has 3/16-in. lead lining which also serves as the cathode of the anodizing circuit. The tank is 3 ft 10 in. wide by 9 ft 1 in. long and 3.5 ft deep. Tellerium lead was used for coils and lining.

While the use of lead pipe for an expansion chamber for a refrigerant gas is unusual, the use of this material is considered feasible where the suction pressure is not excessive.

HEATING AND VENTILATING'S *Reference Section*

Law of Contracts Simplified

Leo T. Parker, Attorney-at-Law

An analysis of higher court decisions on heating, ventilating and air conditioning classified and arranged so as to clarify the principles involved. Prepared in non-legal language especially for contractors and engineers.

PHOTO: "GUARDIAN OF LAW"—U. S. SUPREME COURT

Law of Contracts Simplified

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Much costly litigation and time spent in court, because of controversies resulting from faulty or implied points of a contract, can be avoided through a better understanding of contract law. Not only are many interesting points emphasized, but timely legal decisions are presented to show how current law has been interpreted by rulings of higher courts.

A REVIEW of late and leading higher court decisions discloses that almost all legal controversies involving heating and air conditioning engineers, designers, and contractors relate to contract law. And, approximately ninety per cent of all these contract litigations arise from misunderstanding of purely elementary and simple principles of the law.

Courts have consistently held that a valid contract is any agreement between two or more parties by which each party is expressly or impliedly obligated to do something, not prohibited by law, within a specified time. In an expressed contract the terms of the agreement are stated in so many words, but an implied contract is one where the court presumes or implies that one of the contracting parties is obligated to perform a service or guarantee for the other.

An expressed contract arises where the parties *orally or in writing* agree to the obligations. An implied contract exists where the parties do not actually make a contract but the circumstances are such that a court implied a contract. In other words, frequently the character of an agreement is such that a person is compelled to rely upon the honesty of the other.

For example, in a late and leading decision the higher court held that a heating contractor is duty bound to fulfill an implied guarantee that furnaces which he installed in several homes were reasonably worth the contract price and that these furnaces would give reasonably good service for more than one year. In this case the contract specified that the furnaces were guaranteed for one year, but the higher court implied a guarantee that the furnaces should last longer than one year. See Allied, 35 S. E. (2d) 801.

Thus an implied guarantee arises under circumstances where the court may *imply* that a warranty exists, irrespective of the *contrary* contentions of the contractor.

In Johnson Co. v. Nottke, 51 N. E. (2d) 594, it was shown that a building owner informed a contractor that he knew nothing about oil burners. The contractor's engineer examined the building and prepared plans and specifications. Later the building owner alleged that the heating equipment was inefficient and not satisfactory.

The higher court decided that although the contractor had not guaranteed the job yet he was liable on an implied warranty that the heating system would function reasonably efficiently.

On the other hand, all higher courts agree that an unreasonable delay on the part of a property owner to complain may forfeit his legal rights.

For example, in Tucker v. Willis Co., 48 F. (2d) 783, a purchaser alleged that a manufacturer supplied a casting which would not perform satisfactory service. The purchaser did not promptly complain, but six years later attempted to prove that the casting was cracked and that it otherwise was unfit to render services which the manufacturer guaranteed it would do. Notwithstanding the fact that the defects may have given the purchaser a legal right to *promptly* rescind the contract of sale, the court held the purchaser without remedy, and said:

"A buyer loses his right to rescind and recover the price paid by continuing to treat the property as his own."

Return of Merchandise

Various courts have held that neither a seller nor a contractor is required to accept heating merchandise promptly returned by the purchaser or property owner if the equipment fully complies with the contract. However, if the equipment does not conform with the terms of the contract the purchaser may return the merchandise to the seller, and recover back the purchase price plus all damages. If the purchaser offers to return the equipment and the seller refuses to accept the same, the purchaser may retain the equipment in his possession at the risk of and for the seller.

For illustration, in Economic Water Heating Corp. v. Dillon Supply Co., 159 S. E. 78, the testimony showed that a seller took a contract for 100 heaters. After the heaters were received the purchaser discovered certain important defects and immediately wrote to the seller, and offered to return the defective heaters. The seller refused to accept redelivery and the court was asked to decide whether the purchaser was liable for subsequent damage to the heaters while the same remained in his care. In holding the purchaser not liable, the court stated the following important law:

"The warranty was that if the heaters were not as represented, then the defendant (seller) would accept their return. The plaintiff (purchaser) fulfilled its duty by notifiying the defendant of the breach of the warranty and offering to return the heaters. The defendant declined to accept. The heaters were held thereafter at the risk of seller and subject to its order."

Thus, a property owner, or other purchaser, has a decided advantage over a contractor, or other seller of a heating unit. If the unit does not equal the quality expressed in the contract, or implied by a court, the purchaser may return the unit and sue and recover from the contractor the full contract price *plus all damages* resulting from the breach. And if the contractor refuses to take back the unit, the purchaser may file suit and hold the unit at risk of the contractor.

Quite obviously, therefore, if a heating or air conditioning unit does not comply with the terms of the contract, it is advisable for the contractor, or seller, to take back and keep the unit until termination of a suit, rather than to allow it to remain in possession of the buyer at risk of the seller.

Claims for Breach Must Be Supported

The fact must not be overlooked, however, that a seller or contractor cannot be held liable for breach of a contract, unless the property owner fully and conclusively proves his contentions. In Home, 41 Atl. (2d) 71, the higher court refused to hold a contractor liable for breach of a contract to install an efficient hot water heating system. The property owner had two tenants to testify that their apartments were not well heated, but the higher court refused to hold the contractor liable for breach of the contract. Of course, if the property owner had proved by heating experts that the system was inefficient, it is probable that the jury would have held the contractor liable for a breach of the contract, and the higher court may have approved the verdict.

This is so because where a property owner contends that a contractor breached a contract for installation of a heating system, a jury may consider all testimony and render a verdict. Also, if the property owner sued for damages, the jury may estimate the damages and render its verdict accordingly.

For example, in Siegel v. Strubble, 28 Atl. (2d) 352, it was shown that a contractor agreed to install a heating system, consisting of a furnace, a humidifier and an air conditioning unit. Later the property owner sued the contractor for damages. He proved that the humidifier pan was set up in a tilted position and the water level at the lower end remained below the overflow pipe resulting in operation of the automatic control of the water supply. As a consequence, steam and moisture caused the wood floors to buckle and the plaster cracked.

The house owner had several expert witnesses and building contractors to testify that the cost of restoring the house in its former condition would be $975. The jury held the contractor liable to the property owner for $700 damages. The higher court approved.

Also, in Schultz v. Grand, 19 So. (2d) 862, a property owner sued a general contractor for damages and proved by expert witnesses that the subcontractor breached his contract by installing in a dwelling a warm air system that would not comply with a guarantee that the "system is to be guaranteed to keep the building at 70F D.B. temperature when the outside temperature is 30F D.B. temperature."

The higher court held the general contractor liable in $832 damages. This court also held that the owner could sue and recover damages from the general contractor, although the subcontractor, who breached the guarantee, had dealt directly with the owner and also had submitted the lowest bid to the owner's architect.

Suit Must Be Against Proper Party

For comparison see Rothrock v. Naylor, 28 S. E. (2d) 572, reported March, 1944. It was shown that the seller of city lots made a contract with a company whereby the latter agreed to construct houses on the lots for a portion of the selling prices. This company made a contract with a heating contractor who installed the heating systems. Later this contractor sued *both* the company and seller of the houses for payments due for the heating systems.

The higher court refused to render a verdict in favor of the contractor because the company and property owner were not legal partners.

This court said that suits for damages must be filed against the real and legal owner of the property.

But of course, where a person holds himself out as a partner, the court will imply that he is a partner, at least to the extent of holding him responsible for debts contracted with innocent contractors.

In American Furnace Co. v. Great Southern Air Conditioning Co., 16 So. (2d) 140, it was shown that a person named Neelley furnished capital for an air conditioning partnership and signed the latter's financial statement. Thus it appeared to the seller of furnaces that Neelley actually was a partner in the partnership.

The higher court held Neelley liable to the seller of the furnaces sold to the partnership which failed to pay the bill. This court said:

"This financial statement was unquestionably made up and signed as a means of procuring credit. It effectuated that purpose."

Extent of Damages

As indicated a contractor who breaches a contract to install a heating system is liable for all damages suffered by the property owner, no more nor no less. The amount is determined by a jury.

The case of Furnace Co. v. Loveless, 28 S. E. (2d) 163, is an excellent example of damage allowances. Here a property owner sued to recover damages for an alleged breach of a contract to take out a gas furnace and to install a coal furnace in a residence. The coal furnace would not operate satisfactorily.

The jury held the contractor liable in damage of $175 which was the value of the gas furnace the contractor took from the house, plus $126. The value of the unsatisfactory coal furnace, as installed, was held to be only $25. So, therefore, the contractor was compelled to leave in the coal furnace and pay the property owner $276.

In other words, this court considered only the damages to the property owner. The contractor removed the gas furnace worth $175 and installed a coal

furnace at a contract price of $165, but it was worth only $25 to the house owner, so held the court. Moreover, the court allowed the property owner an additional $126, probably for resultant inconvenience and trouble.

Kinds of Contracts

Broadly speaking, as mentioned previously, there are two kinds of contractors—expressed and implied.

Obviously, all contracts are not valid. The higher courts have established the rule that a contract is valid and enforceable, if these facts are present:

(1) One of the contracting parties submitted an offer which the other party unconditionally accepted.

(2) Both parties have certain obligations to perform.

(3) The subject of the contract is legal.

(4) Both parties are sane and of legal age.

(5) The quantity and quality of the subject of the sale is clearly stated.

(6) The contract does not violate a state or city law.

(7) Neither of the parties practices fraud or deceit.

On the other hand, a contract is void and unenforceable if obtained by one of the contracting parties as a result of direct or indirect fraud, misrepresentation, coercion, undue influence, duress, or threats. Moreover, a contract made without proper authority, or while one of the parties is mentally deficient, intoxicated, under influence of drugs, or under legal age is invalid. Also, certain kinds of contracts are void and unenforceable such as those against public policy, prohibited by a statute, tending to effect immorality and having an illegal object.

If the contract is valid, both the heating contractor and the property owner are bound to fulfill their assumed obligations. Moreover, various courts have held that if either the contractor or property owner breaches a contract the other—

(1) May upon discovery of the breach rescind the contract.

(2) He may sue to cancel the contract.

(3) He may affirm the contract and sue.

It is interesting to know that the courts consistently hold that a property owner *always* is privileged to cancel a contract if the contractor—

(1) Fails to complete a job on the date specified in the contract, whether such contract is verbal or in writing.

(2) He fails to supply the agreed quantity or quality of material and workmanship.

(3) The contractor fails in any other particular detail to fulfill the assumed obligations as specified in the contract plans and specifications.

Question of Liability

According to a recent higher court a property owner may sue and recover his sustained damages from the general contractor and subcontractor who conspire or assist in breaching a valid contract.

For instance, in Burbeck v. Hunt, 171 S. W. (2d) 895, it was shown that a property owner employed an architect to draw plans and specifications for the erection of a building. The property owner entered into a contract with a general contractor to construct the building, under the supervision of the architect, in accordance with the plans and specifications. The general contractor employed a subcontractor to install certain equipment provided for in the plans and specifications.

Later the property owner sued the architect, general contractor and the subcontractor to recover damages, amounting to $1,111, on the grounds that the subcontractor breached the contract. The higher court held the architect, general contractor and the subcontractor jointly liable.

Engineer or Architect Personally Liable

General speaking, the law requires architects and engineers to exercise ordinary care in preparation of plans and specifications. Moreover, each must be reasonably competent and efficient in performance of his work. If either an architect or engineer prepares plans and specifications which subsequently result in a defective structure, he is liable to the property owner in damages.

For illustration, in the leading case of Cornfeldt v. Rihacek, 177 N. E. 522, it was disclosed that an architect prepared certain plans and specifications for a building. Before the property owner employed the architect to prepare the plans, the architect represented that he was a man of much experience and ability.

The contractor followed the plans and specifications. After completion of the buiding the owner discovered much defective work, including the heating system. The jury held the architect liable to the property owner for only $1,000 damages. The property owner appealed to the higher court on the contention that the defects resulting from the defective plans and specifications amounted to at least $5,000. The higher court promptly reversed the jury's verdict, and ordered a new trial saying:

"The finding of the jury that the plaintiff was entitled to recover no more than $1,000 is manifestly against the weight of the evidence. The judgment as rendered does not accomplish substantial justice between the parties."

Matter of Perfection

Modern higher courts consistently hold that neither an architect nor an engineer is legally required to prepare *perfect* plans and specifications.

For instance, in the leading case of Chapel v. Clark, 76 N. W. 62, it was disclosed that a property owner discharged an architect and refused to pay the agreed compensation on the grounds that the latter had prepared faulty and defective plans and specifications.

After thoroughly considering all testimony the court decided that the plans and specifications were *reasonably* perfect and held the property owner liable for payment to the architect of the full amount of the

agreed compensation. This court explained that neither an architect nor an engineer need prepare plans and specifications more efficiently than other reasonably competent and experienced persons in this profession. A review of higher court decisions disclose facts, as follows:

(1) An architect who holds himself out to the public in a professional capacity must be possessed of average ability in such profession.

(2) The law implies that he possesses that requisite degree of learning, and experience which is ordinarily possessed by the profession, the same art, or science, and which is ordinarily regarded by the community, and by those conversant with that employment, as necessary and sufficient to qualify him to engage in such business.

(3) He will use reasonable and ordinary care and diligence in the exercise of his skill—in the application of his knowledge—to accomplish the purpose for which he is employed.

(4) When he possesses ordinary skill and knowledge, and he has used *his best judgment* when preparing plans and specifications, and supervised installation work, he has done all that the law requires.

Excuses Not Acceptable

All architects and engineers are required by law to be reasonably familiar with all appliances and equipment that he includes in his plans and specifications. Therefore, he cannot avoid legal liability for imperfect plans and specifications which include inefficient and inadequate heating equipment on the plea that he was not an expert in heating appliances and equipment.

For illustration, in the leading case of Hubert v. Ailken, 15 Daly. 237, an engineer attempted to avoid liability for improperly specifying special heating equipment on the contention that he was not an expert on these particular appliances. The court held him liable in damages to the property owner, saying:

"He is an expert . . . and he is in duty bound to possess reasonable skill and knowledge as to all these things."

Alteration of Plans

Considerable discussion has arisen from time to time over the legal question: If an engineer prepared reasonably good plans and specifications and the property owner authorized various changes as the work progresses, does the law require the modified portions of the plans and specifications to be as perfect as the original?

This point of the law was thoroughly considered by the higher court in Kortz v. Kimberlin, 165 S. W. 654. In this case a property owner attempted to hold an engineer liable in damages amounting to several hundred dollars for defects in numerous items, including the heating apparatus and equipment, which the owner had ordered changed from the equipment specified in the original plans and specifications.

The higher court held the engineer not liable for damages resulting from the defects and explained that numerous changes ordered from the original plans by the owner is likely to confuse any engineer. Also, in this same case, the owner attempted to strengthen his suit on the contention that the engineer had not exercised care in properly supervising the work to know that inefficient materials were being used.

The court held the engineer not liable on this charge, and explained the law as follows:

"While it is true that a public profession of an art is a representation or undertaking to all the world that he possesses the requisite ability and skill, and it therefore follows that he is presumed to possess the skill and ability necessary to the practice of his profession, . . . yet he does not undertake that his plans will be absolutely perfect, and is liable only for a failure to exercise reasonable skill in the preparation of the plans. Furthermore, if he be employed to superintend he is not liable at all hazards for every defect. He is only required to use reasonable care and diligence in seeing that the work is properly done. The mere fact, therefore, that some of the material is defective, or that some of the construction work is not done in a workmanlike manner is not sufficient to establish as a matter of law that he has not fully performed his contract."

Privilege to Alter Plans

It is well established law that a contractor may assume and be responsible for any unusual obligation not in violation to any valid law.

For instance, in Wilson v. Bond, 48 S. E. 411, a contractor and an owner litigated their disagreement. This contract stated that a specified engineer could alter the heating appliances and equipment plans, as the work was being done. In subsequent suit the higher court held that although the contractor was compelled to do considerable extra work, he could not recover payment for alterations ordered by the engineer.

This court stated that there is no law prohibiting persons from making foolish contracts.

When Plans Are Insufficient

It has been held in numerous cases that an architect or engineer "impliedly" guarantees to supply reasonably complete plans and specifications. In Johnson v. Wanamaker, 17 Pa. Super. 301, it was held that if plans simply are incomplete, requiring only the services of an ordinary draughtsman to perfect the details, then the owner may legally deduct from the agreed compensation *only* the cost of making the simple corrections.

On the other hand, it has been held that if the plans contain "material" defects which only the skill of an experienced engineer can discover, the engineer must pay the increased and total cost of correcting the plans to eliminate defects.

Plans Must Agree With Codes

Another common source of litigation is where an architect or engineer prepares plans and specifications

not strictly in consideration of certain existing laws.

For instance, in Straus v. Buchman, 89 N. Y. S. 226, a property owner sued an architect for damages because his plans and specifications violated the express provisions of the building laws.

The court held the owner entitled to a full recovery.

Also, this court held that an engineer may not avoid liability for his failure to prepare plans and specifications in accordance with valid laws, by simply referring to these laws in the specifications. In other words, he is required to specify and show all necessary lawful details with respect to the materials and appliances to be used. Also, see Nave v. McGrane, 113 Pac. 82; and Trunk & Gordon v. Clark, 145 N. W. 277.

Payment for Extra Work

Modern higher courts consistently hold that a heating and ventilating contractor may recover payment for extras, above the contract price, when the testimony shows that the additional work was ordered by the owner, or whenever additional work or material is absolutely necessary and had not been foreseen by either the owner or the contractor. A contractor is also entitled to recover extra payments when the contract expressly or impliedly provides that the owner will pay for all additional work and materials. The owner is bound to pay for extra work *that he knew* the contractor was doing for his benefit, or when the owner *verbally* ordered extra work, although the contract clearly states that extra work must be authorized in writing.

See Groner v. Cavender, 133 So. 825, where the contract clause provided that should alterations be ordered by the owner, the same must be in writing and attached to the specifications, or the contractor would receive no additional payment.

The owner verbally ordered the contractor to perform extra labor and materials not specified in the contract.

Although the owner refused to pay for these extras the higher court held the contractor entitled to recover a reasonable amount as payment for these extras. This court said:

"Notwithstanding a clause in a contract provides that no claim for extra work shall be made or paid unless the extra work was ordered in writing, a contractor may prove by parol (verbal) testimony, and will recover for extra work, when it is shown that the owner was aware of the work and made no objections to it."

The same rule of the law is applicable when a representative, or an architect or engineer, verbally orders the contractor to perform work or supply materials not specified in the official set of plans and specifications.

See Causte v. Essex, 152 Atl. 640, where a contract stated that all extra work must be authorized in writing. As the work progressed, the architect verbally ordered the contractor to supply extra work and materials.

The court held the contractor entitled to receive full payment for the extras.

Implied Obligations

The law will imply obligations of a property owner which he agreed but refused to assume. This law is important to heating contractors who may assume risks and accept contracts from tenants.

In leading case of Monnig Heating Co. v. Eastom, 27 S. W. (2d) 495, it was disclosed that the owner of an apartment building leased it under a contract which contained a clause that the owner would repair or replace the worn out heating system.

After several months tenants began complaining, and the lessee complained to the owner, that the heating system was inadequate. The building owner refused to install a new heating system, and the lessee made a contract with a heating contractor to install a new and modern steam-heating system.

The owner refused to pay the contractor for the installed system but the higher court held him bound to pay the full cost of installing the new system. This court said:

"Not only was there testimony that cracks had developed in the fire boxes . . . and materially interfered with the efficiency of the plant, but that the entire system had deteriorated to the point where it was more expensive to repair it than install a new one."

Cost Plus Contract

Considerable discussion has arisen from time to time over the legal question: What are the legal effects of a cost plus contract?

In the case of Lytle, Campbell & Co. v. Somers, Fitlet & Todd Co., 135 Atl. 117, the Supreme Court rendered a very important decision relative to the legal meaning of the cost plus plan.

The facts of the case are that an owner and a contractor entered into a contract by which the latter was to supply certain articles to be used in the construction of a building. He, also, was to receive remuneration on the basis of 15% of his cost.

The owner refused to pay the contractor an item for depreciation on the latter's equipment, tools, etc. contending that this amount was not included in a "cost plus" working plan, unless the same was *specifically* mentioned in the contract.

The court held the contractor not entitled to recover the amount and said:

"Appellee (contractor) is entitled to be remunerated for the wages paid to the operator, the power charges to turn over the machinery, the cost of the materials . . . and, finally, the charge for the use of the machine itself may be included, but not depreciation or upkeep . . . "

In another case Johnson v. Kusminsky, 135 Atl. 220, the higher court rendered a decision involving the legal meaning of a cost plus plan contract. Also, the legal effect of an estimate of constructional cost was involved.

The facts of this case are that the contractor entered into an agreement with an owner to furnish all material and do the necessary work at actual cost, plus 15%. The testimony showed that an architect prepared a pencil sketch on which the contract was

based. The contractor testified that he had made no guarantee as to the actual cost, but had estimated such cost, according to the pencil sketch, at from $2,500 to $2,700.

The owner refused to pay the contractor the agreed 15% on the total cost, because the cost of the work amounted to considerably more than the estimate. The contractor then sued to recover payment of $3,862. The higher court held that the contractor was entitled to recover for all work done, irrespective of the estimate, and said:

"Plaintiff (contractor) was entitled to recover for the material—whatever made up its cost, including cartage, storage, operating expenses, etc. In other words, so he would lose nothing on the material, and in addition, recover the 15 per cent, profit on both labor and material . . . In a cost plus contract, operating expenses are properly included as part of the cost of material . . . Where the nature of the case is such that the exact expense of handling material cannot be shown, it may be estimated."

Rights of General Contractor and Subcontractor

Considerable discussion has arisen from time to time over the legal question: What is exact legal rights, liabilities and relationship of a general contractor and a subcontractor?

First, it is important to know that the legal rights and liabilities of a subcontractor depend upon his business relationship with the owner, and principle contractor. For example, a subcontractor who merely is an employe of the owner, or the principle contractor, is not liable for losses from contractors, injuries to workman, or other damages.

Quite recently a higher court explained that where an agreement provides that work shall be done by a subcontractor *who has the exclusive right to use his own judgment as to how the job is to be completed* then, under these circumstances, the relation of contractor and subcontractor exists, and the latter is responsible. But where a subcontractor contracts to perform work for a contractor, or owner, who retains the right to supervise the work, hire and discharge the workman, then the subcontractor legally is a mere employe who is not personally liable in damages, or for contract losses.

In another case, (116 So. 40) where the same point of the law was involved, the court said:

"Where the arrangement is that a subcontractor is to receive instructions from a principle contractor as to how the work is to be done, and has no authority to give directions as to the manner in which it should be performed, or as to the means to be used in performing it, then there would be the relation of master and servant . . . And it is well settled that where one lets a contract to another to do a particular work, reserving to himself no control over such work except the right to require it to conform to a particular standard when completed, he is not liable for the negligence of the party to whom the contract is let, because the relation of master and servant does not exist."

This same court said further that "an independent contractor is one exercising an independent employment under a contract to do certain work by his own methods, without subjection to the control of his employer except as to the result of the work. In other words, when the person employed may prescribe how the work is to be done, or who is to do it, the person so employed is a contractor and not a legal employe. The fact that the work is to be done under the direction and to the satisfaction of a principle contractor, or owner, does not render the person, employed to do the work, an employe."

Thus, the law is well established that the legal relation of a contractor and a mere employe is not to be determined solely by the fact that the owner, or principle contractor, is permitted, to a certain degree to supervise the work. The relationship is determined by the whole contract which exists between the contractor and the employer on its face, and not by a single paragraph.

Irrespective whether a person is a principal contractor or a subcontractor, his liability is the same if he performs work not in accordance with the plans and specifications. A very common source of litigation is where a contractor enters into a contract which stipulates that the owner "reserves the right to alter or modify the work as it progresses."

In view of the numerous previously decided cases involving this point of the law it is certain that a contract of this nature is valid. However, as legal controversies of this kind usually involve the extent of the alterations, which the owner may legally make without paying additional charges, a review of the leading cases is interesting.

In holding an owner not within his rights in ordering certain changes, the higher court explained the law as follows:

"We think that any material departure from the plans and specifications . . . which resulted in a new and substantially different undertaking, cannot be regarded as within the meaning of the contract. We think it was only intended to describe and provide against those ordinary and comparatively unimportant departures from the details in the plans and specifications, which during the progress of the work might become necessary, or at least needed to effectually complete the work as it is contemplated by the plans and specifications . . . We cannot admit that a party entering into a contract to do a given work at stipulated prices, can . . . be made to do different and more expensive work . . . by the architect, or by any of the other parties.

In another case it was disclosed that the contract specified that the owner reserved the right "to modify the work as it progressed." The owner ordered radical changes in the structure and refused to pay for the additional work. The contractor filed suit and in holding the owner liable the court said that such a provision in a contract does not authorize "radical" departures from the work outlined in the plans and specifications, but only authorizes such incidental changes as may have been regarded as necessary to complete the work in "reasonable consideration" of all facts.

Therefore, the law is well established that a pro-

...on in a contract by which the owner reserves the right to modify the plans and specifications as the work progresses, without change in the contract price, legally means that where the owner orders radical alterations the contract price is automatically changed or increased accordingly. In other words, the courts require the owner to confine the alterations to changes that will not unreasonably increase the contractor's expenses.

On the other hand, it is interesting to note that the courts have consistently held that the owner is *not entitled to make deductions from the contract price where he authorizes alterations made by which the contractor is permitted to utilize cheaper fixtures, as heating equipment.*

Also, it is important to know that where a contract specifies that alterations may be made from the plans and specifications by order of the owner, and the contractor proceeds to make alterations ordered by a person who is not an authorized agent of the owner, the contractor is personally responsible for the alterations, and may be compelled by the owner to replace the work in accordance with the original plans and specifications.

Moreover, the subcontractor is likewise affected. For instance, in a recently decided litigation it was disclosed that a contract specified that "no alterations shall be made from the plans and specifications without approval of the owner." The principle contractor proceeded to make alterations ordered by an architect and the various subcontractors were ordered by him to alter their work accordingly. The court held that the subcontractors were not entitled to recover from the owner for the extra work done.

At various times the courts have held that where a disagreement exists between an owner and a contractor or a subcontractor, with regard to a deviation from the plans and specifications ordered by the owner, the question of whether the contractor is entitled to additional remuneration should be submitted to an arbitration board or a jury for careful consideration and decision.

For illustration, in a recent case the testimony showed that a contract specified that the owner "reserved the right" to make necessary changes and alterations in the plans and specifications, as the work progressed. The alterations ordered by the owner resulted in a subcontractor expending considerably more money than would have been expended had the original plans and specifications been carried out. The owner refused to pay the subcontractor for the extra work and the latter instituted legal proceedings to compel him to do so. The details of the controversy were carefully considered by a jury who, also, examined the work actually done, and a decision was rendered in favor of the subcontractor for the amount of his rendered bill.

Guarantee of Work Quality

Still another common source of litigation is where a contract specifies that the completed work shall be satisfactory to the owner. It is important to know that a clause of this kind *does not mean that the owner is privileged to refuse to pay for work simply because he states that he is not satisfied.* Where the work done would be satisfactory to a reasonable person of average intelligence and prudence, the courts hold consistently that the owner is bound to pay for the value of the services rendered.

For example, in a recently decided case involving this point, the court in effect said that where an owner stipulates in a contract that he shall not be required to pay for the work done unless he is satisfied, he cannot avoid settlement simply because he contends the work is not satisfactory, providing the contractor introduces testimony to show that the completed work would be accepted and paid for by a man of average experience and prudence.

Legality of Conditional Bid

Still another source of common litigation is where a contractor, not knowing the exact cost of the work to be done, submits a conditional bid.

For illustration, in a leading case it was shown that a contractor submitted an offer to an owner which specified in part, as follows:

"All materials supplied by us are to be invoiced to you at current market prices, plus 10% for profit. Labor to be charged to you at $1.25 per hour . . . and, if any helpers are required, this time to be charged to you at the rate of 75 cents per hour. We expect the total cost of this work will be in the neighborhood of $600, but it is distinctly understood that the price is merely an approximate one and not binding in any way, shape, or manner."

The contractor proceeded to perform the work and rendered a bill to the owner to the amount of $1,127. The owner refused to pay the bill on the grounds that the contractor had estimated the price to be $600. The contractor then sued the owner for $1,127. The court rendered a verdict in favor of the contractor for the full amount of the bill and said:

"We are referred to many cases dealing with the interpretation of contracts containing the qualifying words 'about,' 'more or less,' etc.; but they are without application here . . . the cost of labor and materials were most uncertain at the time the work was undertaken . . . and estimates were difficult. The offer simply stated that it was expected the total cost would be in the neighborhood of $600, but that it was to be 'distinctly understood that this price is merely an approximate one and not binding in any way, shape or manner.' This was positive warning that plaintiff (contractor) would not be bound by the estimate . . . Under such circumstances, plaintiff (contractor) cannot be bound by the suggested cost, and is entitled to the value of the work done and materials furnished under the terms of the contract."

Broad Contract Law

Up to this point we have covered and explained, in relatively few words, a multiplicity of higher court decisions directly involving all important phases of

heating contractors' law suits. In other words, readers have at their disposal in these previous pages, so to speak, a concise digest for future profitable reference. Irrespective of the heating legal controversy in which you may in the future become involved, you can refer to these cited cases and determine your legal status with reasonable certainty, and whether you can afford to go into court, litigate your differences, and win the suit. Therefore, now for your special benefit, so that you may actually understand the legal reason for past explained higher court decisions, we shall dwell on common contract law especially applicable to sellers who purchase materials and supplies, as well as those who contract to make installations.

When is Contract Binding?

Many legal controversies have resulted from misunderstandings between contractors and sellers with respect to the binding effect of sale contracts. Conditions may arise under which either a contractor or a seller may believe that the other party is obligated, when in fact no binding contract exists. Under these circumstances neither the contractor nor the seller is liable for failure to fulfill the obligations of the intended contract.

Probably the most common source of legal controversies, involving this point of the law, arises from orders given to salesmen. Therefore, it is important to know that the courts have consistently held that an order given by a contractor to a salesman, representing a seller, is not a completed contract until the salesman's employer sends his written, specifically detailed *acceptance* of the order.

In other words, a salesman's only authority, unless enlarged by his employer, is merely to solicit orders and submit them to his employer for acceptance. For this reason, either the contractor or the seller may cancel an order given to a salesman, or rescind a contract of this nature, if such cancellation or rescission is made at any time previous to actual acceptance of the order by the seller.

Relation of Principal and Agent

On the other hand, while this is the general law, it must not be forgotten that the relation of principal and agent exists between an employer and his salesman. Therefore, the seller is responsible for all contracts which the salesman makes within the scope of his authority *made known to the purchaser*. Also, the employer may give a salesman a broad authority to make all contracts relating to the business, under which circumstances the seller is bound to fulfill obligations of all contracts, promises, or guarantees made by the salesman. Yet, if the employer has conferred no unusual authority upon his salesmen, the former is not bound by any contracts made by his salesmen. The seller is not bound to ship an order in accordance with any verbal or written promises of the salesman, and a valid contract is not completed until the employer *unconditionally* accepts the order submitted by the salesman.

Acceptance of Offer

The matter of offer and acceptance is a "meeting of the minds," which is essential to the formation of a valid contract. In other words, an acceptance, to be effectual, must be identical with the offer and unconditional. Otherwise the minds of the contractor and seller "do not meet." Where a person offers to do a definite thing, and the other party accepts *conditionally* or introduces a new condition into the acceptance, his intended acceptance is merely a *counter proposal*, and a valid contract is not completed until the minds of the parties agree upon the new terms.

For these reasons, so long as a contractor withholds assent to the seller's proposed method of making payment, or making delivery, price, or any other materials, no contract exists. This means that the contractor to whom the offer was made may without liability cancel the order or contract at any time before the other assents to the proposal.

Another important rule of the law is that the mere fact that an employer acknowledges receipt of an order sent in by a salesman does not always result in a binding contract.

For instance, in Junius v. Princeton, 279 S.W. 642, it was disclosed that a salesman took an order for building materials. This order was dated November 17. The employer acknowledged receipt of the order on November 22.

The legal question arose whether acknowledgment of the receipt of the order by the seller five days after it was given to the salesman resulted in a binding contract. In holding in the negative, the court said:

"As a traveling salesman's authority is, in the absence of express authority to the contrary, limited to the soliciting of orders and transmitting them to his principal, no sale or contract resulted from the appellee (purchaser) thus giving this order until it was accepted by appellant (seller) . . . . Nor did appellant's (seller's) acknowledgment of the receipt of this order on November 22 constitute an acceptance of the order so as to create a binding contract."

When Valid Contract is Completed

Obviously, since the moment the minds of a contractor and a seller meet a valid contract is completed, several offers and counter proposals may pass between the two parties before a valid contract is completed. This law is applicable with respect to a contractor and a property owner.

For instance, in a leading case (212 N. Y. S. 299) a seller submitted an offer to sell materials. The contractor accepted the offer with the understanding that the seller should keep on hand a sufficient stock to fill his future orders promptly. The seller answered this letter and refused to accept the varied order explaining that he may be unable to keep in stock at all times the quantity of materials the contractor probably would order. The contractor then wrote a letter and simply requested the seller to ship all of the materials he had ready for present shipment.

Litigation developed and it was contended that a valid contract had not been completed. It is interesting

to observe that the court held that the contract was valid and complete, saying:

"In determining the question whether a contract has been established, the court should consider the entire correspondence, and not rest by reading a part thereof . . . . When we read the letters passing between the parties and consider them in their entirety, we entertain no doubt but that an agreement was fully established. It is true, differences subsequently arose between them as to be the true and proper interpretation of the provisions of the agreement, but such differences in no way militate against the proposition that a contract was in fact made."

Sale Induced by Fraud

Under all circumstances a seller or property owner is bound to perform the obligations of a contract when it is shown that he misrepresented material facts in order to induce a contractor to enter into a contract of sale.

For example, in Montgomery v. Jacob Bros. Co., 159 Atl. 374, it was shown that a purchaser refused to pay for purchased merchandise on the grounds that the seller had misrepresented facts regarding the quality of the article. This court said:

"Where false representations as to material facts, which he knows to be false, are made by the seller of an article, and a contract of sale is induced thereby and in reliance thereon, it constitutes fraud on the part of the seller; and, where the contract of sale has been induced by fraud, the buyer may elect to keep the property bought, and, when sued for the purchase price, may, by way of recoupment, show what such property was actually worth."

On the other hand, a contractor who does not rely on misrepresentations made by a seller or his salesman is not entitled to recover damages on the ground of fraud. The same law is applicable when a heating contractor misrepresents facts on which the property owner does not rely. So held a higher court in the case of Phelps v. Home, 46 S. W. (2d) 1090.

In this case it was disclosed that a seller misrepresented facts to a contractor regarding the quality of merchandise. Afterward, the contractor investigated and thoroughly inspected the merchandise and then entered into the sale contract. Later, he contended that the seller had misrepresented facts regarding the quality of the goods. In refusing to render a judgment in favor of the contractor, the court said:

"This admission by the appellant (contractor) shows that he did not rely on the alleged false representations of the appellee (seller), and that they did not constitute a material inducement to him to carry out the contract and to execute and deliver the note to the appellee."

Void and Voidable Contracts

It is well established law that a contractor may without assuming a distinct liability rescind any contract obtained by a seller, or property owner, where the contract is made without proper authority of the latter's employe, or where an authorized employe is mentally deficient, intoxicated, under the influence of drugs, or under legal age.

Generally speaking, the legal distinction between "void" and "voidable" contracts is that neither party may compel the other to fulfill the assumed obligations of a void contract, whereas one party has a legal right to either declare the voidable contract void, or he may require the other party to fulfill the obligations, if the contract is voidable.

Therefore, a contract is invalid by the terms of which only one of the contracting parties assumes an obligation, as in order to comprise a valid contract both parties must assume definite obligations. However, this rule of the law does not mean that contracting parties are barred from obtaining damages for a breach of contract, if both parties *understood* their obligations.

Right to Rescind

A common source of controversy is where a contractor endeavors to rescind a contract contending that he was not fully informed of the contents of the agreement when he signed it. However, it is well established that a contract is not rescindable where it is shown that only one of the parties was mistaken with respect to his assumed obligations. In other words, convincing evidence must be introduced to prove that cancellation of the contract was mutually agreeable to both parties, or that one party practiced fraud on the other party.

For example, in Dixon v. Morgan, 285, the question before the court was whether a contract should be declared void because a contractor signed it while mistaken of his obligations.

This court explained that the general principle of the law, which runs through nearly all of the cases of this character, is that a contract made through mistake of one party can be rescinded only when it can be done without interfering with any legal rights acquired by either party, and without doing injustice to other persons.

Also, in a recent case (289 S. W. 198) the evidence disclosed that a party negligently signed a contract not reading it. Later he discovered that the instrument contained certain stipulations that were not explained to him. Notwithstanding these contentions the court held the contract valid, and said:

"In the absence of fraud, misrepresentation, or concealment, the rule is well established that one who can read and who signs a contract without reading it, and under circumstances which do not preclude an exercise of due diligence upon his part to ascertain the contents of the contract, will not be heard afterward to say that he did not understand the provisions."

Indefinite Sale Contracts

All contractors are daily confronted with contracts having printed thereon notifications relating to cancellation of the contract; authority of salesmen;

delivery of merchandise delayed by fires, strikes, and the like. Therefore, it is advisable to review the late and leading higher court cases involving the modern law on this subject.

The higher courts in all states agree that a reasonable restriction, variation, or modification in a contract is valid and enforceable. This same rule of the law is applicable to letterheads, billheads, confirmation of orders, and the like.

For example, in Charles v. McAdams v. Isaac N. Julian, 155 N. E. 526, it was shown that in a series of letters and telegrams a contractor agreed to purchase a quantity of merchandise. In confirmation of the contract sent by the seller to the contractor a dispensation clause appeared, as follows:

"The seller shall not be responsible for failure to ship according to the terms and conditions of this contract, where such failure is caused by any fires, strikes, labor difficulties, failure of carriers to furnish facilities or acts of carriers . . ."

This clause was printed in large type and located so that the buyer must have observed the same. Also, there was *not* included in the contract any clause contradictory to this printed notification.

Soon afterward the seller's plant burned and it was impossible to fulfill the contract. The contractor sued to recover damages for the seller's breach of the contract. However, the court held the contractor not entitled to recovery, and said:

"Where it appears that the seller is a manufacturer and not a booker, and the contract of sale contains a dispensation clause excusing the seller from performances in cases of fires, strikes, etc., or any other casualty against which there is a dispensation, without his fault, it will excuse further performance."

Inconspicuous Information

Still another interesting point is that the courts have held that printed notification in small and inconspicuous type is worthless, unless the seller specifically directs the purchaser's attention to it.

In a late case (246 Pac. 332) a seller had printed in small and inconspicuous type on its order forms, the following specification:

"Any claim will not constitute cause for cancellation unless the complaint is made within 15 days' time of the delivery of the goods."

The purchaser signed this agreement and several days after the fifteen days' limitation period, specified on the order had expired, he wrote to the seller explaining that the merchandise did not comply with the samples, and refused to pay for the same.

The seller then sued the purchaser to recover the contract price. It is important to know that this court held the purchaser not bound by the printed notice, saying:

"The rule seems to be well established that printed conditions of this kind on letters or bill of lading or order blanks which are not especially referred to or called to the attention of the other party to the contract, will not be regarded as a part thereof."

Therefore, where a letter, bill-head, contract, or the like contains a notice printed in small type, or other type in an obscure location, and unlikely to be observed by the purchaser, it is practically certain that the courts will hold such a notification void and of no legal effect, unless it is proved that the purchaser's specific attention was directed by the seller or his agent to the notice. And this law is applicable although the contents of the notification does not conflict or contradict other portions of the contract.

On the other hand, a notification printed in large and conspicuous type is valid and enforceable, particularly if the party being sued signed the receipt, contract, or other document, and the typewritten or pen-written provisions in the body of the contract do not contradict the printed notification. Moreover, any clause or notification is valid and obligates the purchaser if the seller directed his attention to it. Obviously, this is so because a purchaser is obligated by all lawful provisions in any signed contract. The same is true of heating contracts.

Validity of Guarantee

Both the purchaser and seller are bound by the terms of a guarantee, providing when the contract was made both intended to be bound by the guarantee. However, with respect to guarantees printed on requisition, order or contract forms the law prevails, as above explained, and if the guarantee is conspicuous and made a part of the contract, or the contractor's attention is directed to it by the seller, then the guarantee is valid and enforceable.

If no guarantee is given, but the contractor merely orders merchandise without privilege or inclination to inspect same, the law expects the seller to supply goods "reasonably" worth the purchase price.

Generally speaking, if a contractor inspects merchandise before entering into a sale contract, he is expected by the law to use his own judgment with respect to the quality, quantity and other characteristics of the goods. And if the seller makes no statement which fraudulently induces the contractor to enter into the contract, the contractor cannot complain although the goods are worthless.

See, the case of Cochran v. Peoples, 4 S. W. (2) 515, in which a contractor thoroughly inspected merchandise and finally purchased it without any guarantee on the part of the seller. Later the contractor attempted to rescind the contract on the grounds that when he purchased the goods he believed same were of much better quality. Notwithstanding this contention the court held the contractor bound to fulfill the exact terms of the contract, saying:

"In order to avoid a contract of sale on the ground of fraudulent representations, such representations must relate to an existing fact material to the contract and upon which the other party had a right to rely and did rely to his injury."

Statement of Opinion

It is well to realize that a seller is not liable for fraud or misrepresentation where he merely states his

own opinion regarding the quality of merchandise. And conversely a recent higher court held a seller liable to a purchaser for fraud where it was shown that the seller purposely remained silent about certain defects of the merchandise, thus deceiving the purchaser. This court said:

"A seller may not do anything to conceal from the other a material fact, or say or do anything to divert or forestall an inquiry by him or deliberately hide defects or other facts, for in so doing he is not merely remaining silent, but is taking active steps to mislead." (See 134 Atl. 62).

Frequently, litigations involving contracts require considerable testimony. Now, therefore, in consideration of the almost endless and expensive litigation which may result from ambiguous contracts it is obvious that both buyers and sellers should enter into clear and understandable *written* contracts which do not contain partly printed matter, some typewritten or pen-written matter, or other uncertainties. Under these circumstances complicated testimony pertaining to uncertain contracts is avoided.

As mentioned, frequently the intended uses of merchandise are such that the contractor is compelled to rely to a great extent upon the honesty of the seller to supply merchandise reasonably fit for the intended purposes. Under these circumstances the courts will compel the seller to supply a quality of merchandise which is reasonably good in consideration of the sale price. This law, however, does *not* prevail where the seller gives an *expressed* guarantee, or if the written contract clearly states that no implied guarantee exists, or if a requisition, order or contract form contains a conspicuous notification to the contractor of the quality of the subject of the sale. On the other hand, a fraudulent statement on the part of the seller invalidates any written guarantee, and contract.

For illustration, in Ferguson v. Kick, 268 Pac. 343, it was disclosed that a buyer and a seller entered into a sale contract which specified that the merchandise was sold "as is." Before the purchaser signed the contract the seller verbally guaranteed the merchandise to be of high grade quality. The buyer discovered that the seller's verbal statement was false and he sued the seller to recover the purchase price which he paid for the merchandise.

The seller contended that the testimony was not admissible because the written contract clearly contained the "as is" stipulation. However, under the circumstances, the court held the seller bound to take the merchandise back and refund the purchaser's purchase price, explaining the law as follows:

"A purchaser has a right to rely on the presentations of the seller as to facts not within this knowledge, and the seller cannot escape responsibility by showing that the purchaser might have ascertained upon inquiry that the representations were untrue."

Legal Fixtures

Many contractors fail to realize the importance of the law relating to "legal fixtures." Broadly speaking, a legal fixture is any equipment, as a furnace, installed or attached to a building in such a manner that its status is changed from a chattel, and it actually becomes a part of the real property. Therefore, it cannot be removed from such building by the contractor, or other person, for any purpose or reason except by direct permission of the owner or new purchaser of the building.

Of course, legal fixtures usually relate to relatively securely attached subjects of sales. In other words, a legal fixture cannot be merchandise placed in storage for future resale, nor can it be ordinary small articles which merely occupy a building without being attached to it. But articles in all other classifications, as furnaces, permanently attached to a building may be legal fixtures which the contractor, to his amazement and financial loss, discovers can be prevented from being removed by the owner of the building, or one holding a mortgage on the building, or a new purchaser of the building.

In other words, contractors frequently find themselves confronted with controversy after a person purchases a building and he notifies the contractor not to remove certain articles from the building, although the seller of the building did not pay the agreed contract price. The same situation exists when the holder of a mortgage on a building forecloses. Frequently the holder of the mortgage as a contractor, may attempt to prevent the owner of the building or the new purchaser from removing equipment and other personal property from the building.

Moreover, a contractor may experience legal difficulty, when attempting to remove heating equipment from a building, if either the owner of the building, or a new purchaser of the building, or one who forecloses a mortgage or a mechanics's lien objects, although the contract between the buyer and the heating contractor clearly specifies under what circumstances the contractor may remove the equipment from the building.

On the other hand, although a building may be damaged by removal of heating equipment the lessee of a building may remove it providing it was originally agreed between the landlord and lessee that such equipment could be removed, and the original landlord now owns the building.

In a leading case, Ballard v. Company, 93 Wash. 655, it was shown that heating equipment was installed in a building by a tenant without any intention of making it a permanent accession to the leased building. The equipment was attached in a manner that it could be quickly removed without any material injury or damage to the building, although to do so required tearing away of certain walls which the lessee or tenant could replace. In holding the tenant entitled to remove the equipment from the building, the higher court said:

"In determining whether a chattel which has been annexed to the freehold is a trade fixture or a part of the realty, the cardinal inquiry is into the intent of the party making the annexation. It is conclusive, of course, that the chattel annexed is a fixure when it cannot be removed without a material injury to the freehold, as for example, where it is essential to the support of some part of a permanent structure."

Fig. 1. Aluminum ducts in the United States Army Map Service Building, Washington, D. C. Added brilliancy was secured by hanging the fluorescent lighting fixtures beneath the ducts.

A Material for Industry

Aluminum for Duct Work

H. F. JOHNSON

Architectural Division, Aluminum Company of America

STEMMING largely from critical sheet metal shortages, many thousands of pounds of aluminum are now being effectively utilized as a material for heating and ventilating duct work in industrial and domestic installations. Recognized for its inherent light weight and ready workability, uses have shown ease of forming and application, and extremely high resistance to corrosion. Moreover, appearance and good reflectivity of the metal have paid dividends in large public and industrial buildings where illumination is a costly factor.

This company's specifications for aluminum in duct work provide, among other things, that metal seams be grooved, standing, S slip, end slip, double seam, Pittsburgh seam bar, angle connection or angle bar slip. Type of joint used is governed by Table 1.

Table 1—Type Joint for Various Duct Sizes

Round Duct Dia., In.	Rectangular Max. Side, In.	Type of Joint
Up to 32	Up to 30	S slip
32 to 45	30 to 45	Bar slip or government lock
45 to 60	45 to 60	1½ in. angle bar slip, or 1½ in. angle connections
60 and up	60 to 90	2 in. angle connections
	90 up	2¼ in. angle connections

Further development data, supplied by Alcoa research engineers, suggests that slip lock connections should be riveted to the duct about 2 in. from the slips. End slips may be used in those cases where S slips are suggested, and flat surfaces may be cross-broken to help prevent vibration. Accordingly, bracing should be provided as in Table 2.

Table 2—Bracing for Ducts

Size, In.	Bracing
Up to 24	None
24 to 32	1 in. angle 4 ft from slips
32 to 45	1¼ in. angle 4 ft on centers
45 to 60	1½ in. angle 2 ft 8 in. on centers
60 to 90	2 in. angle 2 ft 8 in. on centers
90 up	2½ in. angle 2 ft 8 in. on centers

Aluminum heating and ventilating ducts which are to have sound-deadening properties should be lined on the interior with asbestos fibre board or other suitable rigid board material possessing sound absorbing and fireproofing characteristics. Board should have smooth painted surface and the lining should be fastened to the duct with aluminum, galvanized steel or stainless steel fastening devices. For aluminum ducts which carry high humidities, a coat of good quality bitu-

minous paint before installation of sound-deadening equipment is suggested.

Final selection of proper duct gauge should be made on the basis of actual design conditions. Table 3 is suggested for gauge determination.

Table 3—Gauge Selection for Various Duct Sizes

B & S Gauge	Net Wt. lb per sq ft	Thickness Inches	Round Ducts Dia. In.	Rectangular Ducts Max. Side, In.
24	0.287	0.0201	Up to 16	Up to 12
22	0.361	0.0253	16 to 24	12 to 24
20	0.456	0.0321	24 to 32	24 to 32
18	0.575	0.0403	32 to 45	32 to 48
16	0.724	0.0508	45 to 60	45 to 60
14	0.914	0.064-0.0808	60 up	60 up

*Weight for alloy 3S; multiply by 0.97 for 52S; by 0.99 for 61S.

Metal gauge should be such that the natural frequency of the duct (or any part of it) will not synchronize with the frequency of impulses of the fan blades or motor used in the system. Natural frequency of the duct or member may be estimated by the following helpful formula:

Natural frequency of vibration $= 3.13/\sqrt{D}$ cycles per second.

D = deflection at center of span of duct or member resulting from its own weight plus attached weights.

Example: 32 in. wide rectangular duct of 0.0403 in. thick aluminum.

Calculated deflection = 0.991 in. (without consideration of additional stiffness offered by cross-breaking)

Frequency $= 3.13/\sqrt{0.991} = 3.14$ cycles per second.

In keeping with reduced vibration in the system, the fan or motor frequency cycles should lie outside a range of one-half or twice the frequency of the duct width. In effect, a fan with eight blades operating at 1,700 rpm would have a frequency of 226 cycle per second, which is over twice the natural frequency of vibration of a 32 in. wide duct in 0.0403 in. thick metal. Motor frequency is 28 rps which is outside one-half of the natural frequency of the duct width. Duct bracing and hangars should likewise provide an integral structure so that the natural frequency of the whole unit complies with the above conditions.

Chief advantage of aluminum as a duct material is its excellent resistance to highly corrosive atmospheres. In this direction, an example of its durability is shown in the use of aluminum hoods and ducts at Alcoa's aluminum research laboratory, New Kensington, Pa. Installed in 1929, these ducts, althought darkened in appearance, are considered in perfect condition today and have required no special maintenance or replacement. Inasmuch as the fumes conveyed through these ducts are highly corrosive (as would be expected from a metallurgical and chemical laboratory where great quantities of hydrochloric, sulfuric and nitric acid are used), the ducts themselves have been entirely successful as air conditioning hood material. Almost 20 years service in this extreme application points to many factory and laboratory installations where long-range use of the metal would be most economical.

Several large midwestern sheet metal manufacturers are currently employing large amounts of aluminum for both industrial and domestic heating and ventilating installations. An average of 150 pounds of aluminum goes into each home application. Most popular alloys among sheet metal fabricators are 2S-½H and 3S-½H coiled sheet.

In line with the popularity of the metal for this purpose, many distributors are arranging through larger suppliers for the packaging of individual heating duct units, each containing a complete set of aluminum ducts and fittings for a modern, warm air conditioning installation. The packages vary in size to accommodate small homes of from four to six rooms and contain an average of 150 lb aluminum per packaged unit. Other recent distributors of aluminum ducts are large mail order companies, now selling aluminum exhaust and intake fans in conjunction with aluminum heating and ventilating units.

Typical of large-scale postwar installations is the United States Army Map Service Building in Washington, D. C., which consumed over 140,000 lb of aluminum for duct work, tubing, fans and fittings. This recently-completed 5-story building, with 330,000 sq ft of floor space devoted to map production, is completely air conditioned and is equipped with 28 exhaust and 18 supply fans which operate the system. Porter and Lochie, Washington, D. C., were the architects and Wm. K. Karsunky, consulting engineer for mechanical and electrical air conditioning.

The thousands of running feet of ducts for the air conditioning, heating and ventilating systems were fashioned from 3S-½H sheet, which Standard Engineering Co., the contractors, found best suited for duct installation. Only hangars and strap hangars were fabricated from galvanized iron materials.

When completed, fluorescent lighting fixtures were hung in many cases directly underneath the ducts, Fig. 1, presenting an attractive appearance. Moreover, the reflectivity of the aluminum added brilliancy to the office illumination.

Aluminum's excellent workability and ease of erection have met with widespread approval from the heating and ventilating trade. The fact that the metal was used extensively during the war years by thousands of defense workers has largely accounted for its present popularity. Machining and fabricating techniques have been instilled in thousands of metalworkers who knew little about aluminum before the war. Availability of the light metal today in the face of severe shortages of competitive materials has also accounted for its acceptance in these markets. Thousands of sheet metal shops now stock aluminum as they once stocked galvanized iron.

Calculating Heat Transmission through Plexiglas

IN the accompanying alignment chart the variables are the air velocities on each surface of the Plexiglas panel and thickness of the panel. When these are known, the overall coefficient of heat transfer through the panel (in terms of Btu per square foot per hour per F temperature difference) may be determined from the chart.

To use the chart, locate the air velocities at each surface of the panel on scales (1) and (2); then locate the point on scale (3) which is determined by the intersection of a straight line drawn between the chosen points on scales (1) and (2). This point on scale (3) is then lined up with the point on scale (4) corresponding to the sheet thickness and the coefficient is read from scale (5). Multiplying this coefficient by the temperature difference (in F) between the air at each surface, and by the area (in sq ft) will give the number of Btu transferred through the panel per hour.

Example 1. What is the rate of heat loss from a 0.125-inch thick Plexiglas window with zero (0) air velocity (convection) on the inside and a 20 m.p.h. wind on the outside, the air temperature difference being 60F and the area of the window 12 square feet.

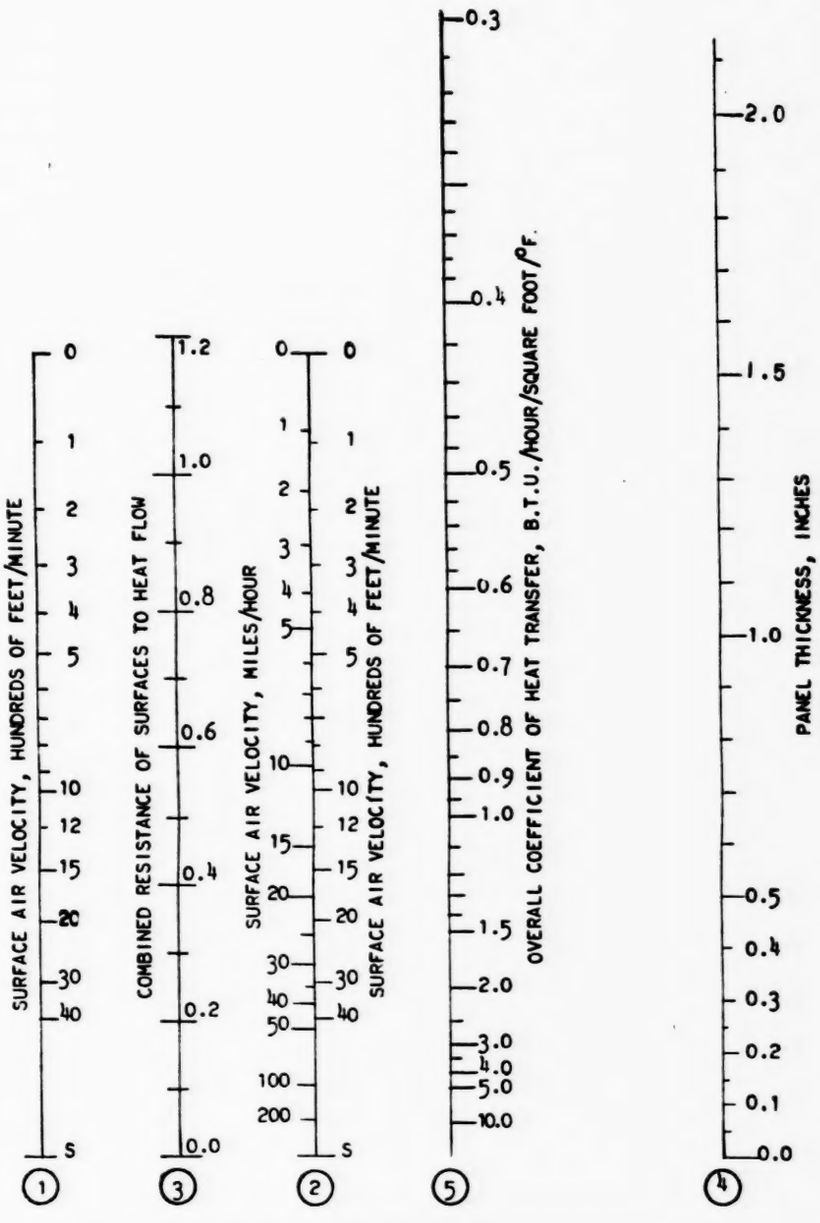
Solution. Lay a straight edge between the zero (0) mark on scale (1) and the 20 m.p.h. mark on scale (2) intercepting scale (3) at 0.77. Then lay the straight edge from this point on scale (3) to the 0.125 inch mark on scale (4). The coefficient 1.15 is read from scale (5). The rate of heat loss can then be calculated as $1.15 \times 60 \times 12 = 830$ Btu per hr.

The chart may also be used if the temperature drop between the surfaces of the panel itself is known rather than the drop from air on one side to air on the other. In this case the zero (0) mark on scale (3) is lined up with the sheet thickness on scale (4) and the coefficient again read from scale (5). In this case the coefficient will represent Btu transferred per F, temperature drop across the panel only, per square foot, per hour.

Example 2. A tank made of ½-in. thick Plexiglas has 13 sq ft of wall area. It is used to hold water at 120F. The temperature of the outside of the tank is found to be 100F. What is the rate of heat loss?

Solution. The inside surface of the Plexiglas may be assumed to be at the same temperature as the water, so the temperature difference of 20F, is across the panel. Line up the straight edge between the zero (0) mark on scale (3) and the 0.5 inch thickness mark on scale (4). The point of intersection with scale (5) determines the coefficient of heat transfer, in this case, 2.6 Btu per hr sq ft F. The rate of heat loss can then be calculated as $2.6 \times 20 \times 13 = 680$ Btu per hr.

The chart may also be used where the temperature



Alignment chart for determination of heat flow through Plexiglas panels.

of one surface of the panel is known and the air temperature beyond the other surface is known. In such a case, the straight edge is set at a point on scale (1) or (2) corresponding to the air velocity on the side on which the temperature of the air is known. The straight edge is set at S on the other scale (2 or 1) and the intercept on scale (3) determined as before. This intercept is used together with the thickness point on scale (4) to determine the coefficient from scale (5).

Example 3. The tank in Example 2 is surrounded by air at 70F, which is not stirred. The water is at 120F. Find the heat loss.

Solution. This time the straight edge is lined up between zero (0) air velocity on scale (1) and S on scale (2) and the value 0.59 is determined on scale (3). This point is lined up with the 0.5-in. mark on scale (4) and a coefficient of 1.05 is read from the intercept with scale (5).

Then the rate of heat loss value can be calculated to be $1.05 \times 50 \times 13 = 680$ Btu per hr.

Other Thermal Properties

The coefficient of expansion e of Plexiglas I-A for the temperature range of —50C to + 60C is

$$e = 0.00000037t + 0.00007$$

where e = the coefficient of expansion per C,
t = temperature, C, with proper plus or minus sign.

The specific heat of this material is 0.353 calories per gram per C for an average temperature of 25C.

The data in this article are presented through the courtesy of the manufacturer of Plexiglas, Rohm & Haas Co., Philadelphia.

Causes for High Toxic Vapor Dispersion from Degreasing Installations

There are many causative factors which may be responsible, individually or in combination, for high toxic vapor dispersion from degreasing installations. These may be listed as:

1. Open windows adjacent to unit.
2. Openings, adjacent to unit, between plant operating areas.
3. Man cooler fans or unit heaters which tend to drive vapors out of open degreasing tanks to the breathing zone of the operator and/or to the general work area.
4. Excessive and uncontrolled steam pressure at heating coils.
5. Uncovered steam line feeding heating coils. The aspirating effect of the thermal air currents at the sides or rear of the unit act as ejectors to the air in the vicinity of the unit. Once air movement starts, a condition of unstable equilibrium exists with resulting vapor movement from within the tank.
6. Insufficient cooling water feeding cooling coils or cooling jackets. This is usually an important, though rarely checked factor which may cause excessive vapor dispersion from the tank.
7. Cooling water to the unit is too warm. In some localities this is a problem, particularly during the summer months. Increased water quantity may be the only economic answer to this problem.
8. Uncovered stack, leading to outdoors, conveying products of combustion from gas-fired units. The action in the vicinity of the tank is similar to that described under item No. 5.
9. Use of trichlorethylene solvent in units designed for perchlorethylene solvent without any change being made in thermostat setting. *Fundamentally, the solvent recommended by the manufacturer of the unit should only be used in the unit.*
10. Excessive upward or downward movement of work into or out of unit. This is probably the most important item causing excess toxic vapor dispersion to the breathing zone of the operator and is one which is most difficult to control particularly with hand-operated units.
11. Excessive drag-out of solvent due to faulty racking of material or due to recesses in materials being processed.
12. Unnecessary hand shaking of basket of degreased parts to remove excess solvent. This is usually done while the basket is either being withdrawn from the tank or is directly in the breathing zone of the operator. With round baskets, some operators usually roll the basket along the inner forward edge of the tank. Excessive vapor concentrations in the breathing zone result, with loss of valuable solvent to the clothes of the operator and to the floor area in front of the tank. This results in re-evaporation of the solvent to the general work area.
13. Location of unit adjacent to exhaust systems such as buffing and polishing, metal cleaning tanks, spray booths or wall propeller fans.
14. Location of unit near stair or elevator wells.
15. Location of unit close to machinery operated by belts from line shafts or jack shafts.
16. Too many operators, not properly instructed, using unit.
17. Covers on units not used when unit is not operating continuously.
18. Sluggish action of thermostatic controls.
19. Excessive metal load in unit far beyond the original design requirements.
20. Excessive operator activity or speed about or in front of unit, which with item No. 10 may be responsible for much of the exposure at degreasing units.
21. Poor operator technique with re-emphasis of items No. 10, 11, 12, 16, 17, 19 and 20.

B. F. Postman, Industrial Hygiene Engineer, Employers Mutual Liability Insurance Co.

Radiant Heating *Plus* Convection Heating

T. NAPIER ADLAM

Vice-President, Sarco Mfg. Corp., and Consulting Engineer on Radiant Heating

A comment on A. G. Dixon's article in the December issue "Will Radiant Heating Displace Convection Heating," in which Mr. Adlam contends that both radiant and convection heating have their places – frequently on the same job.

AS I write these notes I am sitting in a room heated partly by radiant panels and partly by convection. Looking through the window I can see the snow flakes melt as they fall on the black surface of my driveway, and I am reminded that the surface is kept warm by the pipes which are embedded below the asphalt. This in turn reminds me of Mr. Dixon's article in the December 1946 issue of HEATING AND VENTILATING on radiant heating versus convection heating, with subsequent articles and comments in later issues.

Recalling some of Mr. Dixon's remarks vindicating the use of convected heaters, I would like to add a few words to those which have already appeared, but viewing the subject in a better perspective, I prefer to make my remarks under the heading as given above.

Many of Mr. Dixon's conclusions are, as far as we know, perfectly true, and in this writer's opinion there appears to be no reason to decry radiant heating for the purpose of promoting convection methods of heating.

Convection heating has its drawbacks, but so has every other method of heating, as we invariably discover when we have to consider the many types of buildings being erected and try to design a suitable heating system which will be efficient, healthy, clean and, at the same time, take up a minimum of space.

If we really wish to consider convection heating on its merits, then we are faced with this question: Has convection heating given entire satisfaction in all respects? We have had it in various phases for many years and should know its advantages and disadvantages. If it has given entire satisfaction and it continues to meet the health, comfort, and aesthetic requirements of the public, then the manufacturers of convector heaters should have no fear of the future. If, on the other hand, there is a case against convected heat, either in the manner it is applied, or the effect it has on the human body, then the public is justified in seeking some other method of heating which will give them clean, comfortable, and healthy homes.

It is regrettable that Mr. A. H. Barker should be accused of being an aggressive engineer simply because he brought to light the truth which is now commonplace, i.e., that the human body is more comfortable and healthy when exposed to surfaces slightly warmed, and to an atmosphere which has not been dried and burnt from being passed over a high temperature surface. Anyone who knows the true story of how radiant heating was introduced cannot accuse my friend Mr. Barker of being aggressive, or even mercenary, in this particular phase of heating.

Admittedly, we have found some Sunday papers and periodicals using extravagant phraseology in describing what radiant heating can do, but we can find equally extravagant advertisements in our own technical papers as to what the buying public can expect from many other products which go into the average heating system. The user is never told how much he has to clean, or that if he wishes to keep warm he must put up with a few electric sparks which fly from person to person, or person to door handle.

To whom can the uninitiated public turn for help in their efforts to find the best type of heating with the smallest possible expense? Consulting engineers, architects and well informed contractors are available but not too easily so to most people. The layman has been trained by experience with autos and many appliances to rely on two important sources of information—manufacturers whose names are familiar to him, and second, universities and colleges. On the one hand we have the manufacturer of the commodities which make up the equipment used in the various types of heating, each claiming the system using his products gives the best results; then we have the scientists who theorizes to the limit frequently with little practical experience.

The manufacturer has to sell his goods in open competition and may be forgiven when, as one enterprising heating engineer once deftly put it, "It sometimes becomes necessary to pocket ones principles to get on in the world."

Why then should we feel disturbed because pipe manufacturers make an attempt to advertise their wares and tell the public of a newer and cleaner method of providing comfortable homes? Unfortunately, in these announcements there sometimes does appear to be more zeal than prudence and more guess than experience, but this does not mean that the principles of radiant heating are unfounded. In most cases it seems that these exaggerated statements originate from lack of knowledge, because even the most elementary rudiments of heating are ignored or forgotten. The householder is not concerned about what kind of a formula we use to obtain the required amount of heat in the various rooms of his home, whether it be a simple arrangement of figures and letters, or a complicated array of mathematical conjectures. The housewife needs something clean and efficient, something

which will give her less to do in her rounds of daily chores. There are many places where it becomes a very valuable asset to have some convected heat, and there are places where it is nigh impossible to provide adequate heat from radiant panels alone. However, I have vivid memories of the dirt and filth I discovered on many occasions when, as an apprentice, I helped to remove indirect or convector heaters from behind grilles which had been used to heat classrooms and residences for many years. I have visions now of convectors installed within recent years in places where they never can be cleaned or inspected without pulling down part of the building.

These are the things which should be carefully considered when any kind of heating unit is being installed —whether in a home, office, or other building, and whether it is a convection heater, a radiant panel, or a combination of both.

The slow moving air in a room with convector heat will carry particles of dirt, pile from carpets, and any organic matter floating in the air and deposit these on the surface of a heater over which the air has to circulate; consequently, a heater provided with easy means for cleaning the surfaces will go a long way to remove one of the serious objections to convected heat.

When we are considering the question of heating a factory, we often find that some convected heat is absolutely essential. I have recently designed the heating system for our new plant at Bethlehem, Pennsylvania, and there we have embedded pipes in concrete floor supplemented with unit heaters to take care of the extra heat for ventilation. The concrete floor is built over a very damp and cold soil and the embedded pipes will insure perfect comfort and health to all employees. In a new block of offices adjoining this factory, and first occupied about two years ago, we have adopted radiant heating everywhere, but constructed in various ways to suit the building. These methods include plastered wall panels, concrete floor panels, oak floor boards on joists with pipes between the joists, ceiling panels with plaster, and some metal panels for concentrating heat.

In my own home I have convected heat for the living and bed rooms, floor heating for the sun-porch, and wall heating for the basement.

I mention these things to show that a heating engineer should not be biased in his views on the method of heating, and should decide on radiant, convector, or cast iron radiators on the basis of what the building demands.

With convected heat only, I find it is often impossible to obtain a correct balance of heat in the basement with the rest of the house, simply because the walls and floor of the basement are colder than the walls and floor of a well insulated house and, therefore, the heat emitted as warm air is required more consistently in the basement than in the living rooms.

The floor of the sun-porch is constructed with polished oak boards with pipes between the supporting joists and, so far, there has been no sign of shrinkage. The game room in the basement, which is also used as a study, is 28 ft by 12 ft, and the walls throughout are panelled with knotty pine boards with pipe coils placed behind the wood on one side of the room only. Here again, there is no sign of shrinkage or warping of the wood panels.

The warm air unit with air conditioning gives satisfactory results, although if I were building a new home, I would undoubtedly install radiant panels everywhere, with a snow-melting system for the sidewalks and driveway.

To insure the satisfactory working of the warm air unit I clean the filters every month and renew them every year. However, I often wonder how many householders ever think of cleaning filters, or the heated surfaces over which the air they breathe has to pass.

It should not be construed that because radiant heat meets many of our requirements that radiant heat is the answer for every building. If we face facts we shall find that there appears to be no one thing suitable for all conditions within its category, whether it be a particular type of heating system, a steam trap, a control, a valve, or a war machine. Some types of controls are found suitable for individual rooms, but are totally unsuitable when applied to a building with several rooms of varying thermal capacities and heat losses.

It is stated in Mr. Dixon's article that Britain has had her share of headaches with radiant heat, a statement which is perfectly true. I have seen some very unsatisfactory radiant heating systems in England, and we already have some very sour jobs in this country, too. I am afraid we shall have more of these in the process of time, but only because the real art of heating seems to be still very little understood.

This does not necessarily apply to radiant heating alone, and if a conscientious survey of all the heating systems installed in the last 30 to 50 years were made, I wonder how many really good jobs we could find. Those one-pipe steam systems with the stifling heat, radiators or convectors hidden behind grilles already covered with dirt, warm air units where the filters are never examined, and so forth.

The danger now is that data obtained from a few meager tests perhaps under extreme or special conditions, will confuse the issue with which we are dealing.

I have noticed that it is erroneously claimed by some that if the floor of a workshop is heated, the heat loss through the roof may be neglected. This is not true, and we must realize that where we have a temperature differential we must have a transfer of heat, the amount of which will depend on the temperature difference and the media through which the heat will travel, and so on. We have to provide that heat which is lost through the roof, and this is often where convected heat comes to our aid. Where the heat loss through the roof has been ignored when designing a radiant heat system, I find that it becomes necessary to heat the floor to an excessive temperature, and this gives rise to complaints and makes the occupants not only uncomfortable, but also more susceptible to colds when going outside in wet or snowy weather.

Within the last month I have been called upon to give advice on the best method of heating three separate very large buildings. One is to be used for

storing and repairing motor vehicles, one for airplane repairs, and the other for food processing. In each case I recommended floor heating supplemented with unit heaters to take care of ventilation, humidity, and other important factors. The floor panel will take care of all heat losses below a certain datum line and provide a comfortable atmosphere and a warm floor where the workmen can operate. The unit heaters, some of which will be made to take in fresh air or recirculate in part or in whole, will make the system efficient and very economical.

Within the last week I have given advice on a fairly large housing project with a number of well built one-story houses. For these I recommended ceiling panels with copper coils for all rooms except the living rooms, which are designed to have wood floors and open wood ceilings with beams. For the living room in each house I recommended steel or wrought iron pipes under the wood floor, supplemented with low cast iron radiators or convectors under the windows.

The temperature of the water circulating through the coils of the ceilings will be controlled by an outside thermostat, with individual manual controls for each room. Regardless of what may be said to the contrary, I find that for the majority of buildings, there is nothing so reliable as a control relying primarily on the outside conditions for its modulation, supplemented with a reliable type of room comfortstat to give final selectivity. The temperature of the water circulation in the coils for the air space under the floor of the living room must, of course, be at a much higher temperature than the water circulating in the ceiling panels. Therefore, the water for the floor coils and convector heaters will circulate direct from the boiler and be controlled by a combination comfortstat.

I think we should be perfectly fair about our ideas of heating, for although it has taken many years to bring the truth into the home, it is now commonplace that when the human body is surrounded with warmer surfaces, it can be more comfortable and healthy with a lower air temperature.

As Mr. Dixon tells us, if we insulate the walls, ceilings and floor, and use storm windows throughout, we can, with convectors, get closer to the ideal conditions which radiant heating provides. In other words, if we maintain a greater mean radiant temperature we can reduce the air temperature and, naturally, the total heat loss from the building.

If now we can do something so that the owner, and especially the housewife, will have a system which will create the minimum amount of dirt, or something which she can easily clean, we are getting somewhere.

The health authorities should also consider this aspect in connection with schools and public buildings, but don't let us be afraid of the truth, or are we?

For large factories, it seems to me that some radiant heat panels, carefully designed and located, supplemented with unit heaters, appear to approach the ideal arrangement, except where special equipment is necessary to deal with peculiar conditions.

I Agree—There Is a Place for All Forms of Heating

A. G. DIXON
Secretary, Modine Manufacturing Co., Racine, Wisconsin

In this rebuttal – which closes the discussion – Mr. Dixon clears a misunderstanding, restates his position, and urges tolerance and receptiveness toward all methods which promise progress.

I AM grateful that even those who have differed from my views as expressed in the December article, "Will Radiant Heating Displace Convection Heating," have been invariably courteous and fair in their comments. I want to express my appreciation of Mr. T. N. Adlam's observance of this same spirit, in what he has had to say regarding the article.

I would like immediately, however, to clear up a wrong understanding which Mr. Adlam quite apparently has drawn from certain early paragraphs of my article. This misinterpretation is almost amusing in its origin, inasmuch as it typifies the kind of thing that occasionally grows out of differing American and British usages of the English language; in its effect, however, the misconstrual is on the serious side. Mr. Adlam has obviously understood that I was discourteously critical of his British friend, Mr. A. H. Barker, Mr. Adlam saying "Anyone who knows the true story cannot accuse my friend, Mr. Barker, of being *aggressive, or even mercenary*" (italics are mine).

What I said, it may be recalled, was this, "To his credit, Mr. Barker was not only a keen observer, but also an aggressive engineer. He set about deliberately to reproduce this phenomenon which he had found good, putting pipes into the walls of rooms, etc."

My intention was to be wholly complimentary to Mr. Barker and *in American usage* I was being definitely complimentary to Mr. Barker. In the United States we are speaking favorably of a man when we say that he is an aggressive business leader or an aggressive research engineer; we mean that he employs initiative and that he takes the aggressive in attacking *the problems* of his chosen field of activity. In Britain (I now have learned) when a man is called aggressive

the implication is derogatory, since it implies that he has a tendency to make unprovoked attack upon his fellow man.

While there is no seeming occasion for an apology under the circumstances, I do want to express regret that the term as used was open to misconstrual through British-educated eyes. I believe that Mr. Adlam will be able to satisfy himself as to the sincerity of what I have just said, by reviewing the point with some of his American friends.

To turn now to the technical phases of Mr. Adlam's comments: Mr. Adlam presents the advantageous factors of radiant heating ably and temperately. I only wish that this same temperateness might accompany panel heating presentations more generally. A reconsideration of what was said in my article I believe will reveal that I was not critical of radiant panel heating in principle but was critical primarily of the gross exaggerations which have been made in the name of panel heating—dinned into the public ear by clever propaganda. I have referred to the screw-ball period through which air conditioning passed in this country a decade ago and said that this hurt air conditioning seriously; does anyone disagree as to either the existence or the seriously harmful effect of that purported fact? I have said that I felt that panel heating was getting a build-up of public misconception and exaggerated expectation, similar to that which was associated with air conditioning 10 or 12 years ago and I have inferred that there would be a parallel Humpty-Dumpty act, with panel heating representing the egg that would get smashed or badly cracked in terms of public acceptance and good will, if the distortions and exaggerations being applied to the subject of panel heating were not curbed.

Of course, I cannot prove this point that I drew in my article and have here restated, for only time can speak as to this. Actually and sincerely, I am hoping that this will not occur and I believe that in urging temperance and discretion I am a better friend of panel heating than those who claim a sun-God character for it, who proclaim that it saves fuel and who imply that panel heating is wholly perfected and should be universally adopted.

One could hardly sit in the Forum on Panel Heating held at the recent ASHVE annual meeting in Cleveland and escape the conclusion that panel heating is both complex and immature. I think it is thoroughly justifiable, in fact, to state it this way, *"Panel heating is exceedingly complex and is decidedly immature."*

May I incidentally mention that my usage of the term "convection heating" was quite generalized; in this I have merely accepted the appellation of panel heating enthusiasts as applied to all heating which is not panel heating. They classify everything else, as I understand it (including heating by convectors or radiators, winter air conditioning and even warm air furnace heating), as "convection heating."

However, as to the convectors which came to Mr. Adlam's attention: These must have been of a quite early vintage to have been so dirty; the modern convector is trim and easily cleaned, having usually a removable front for accessibility (not only for cleaning but for the servicing which unfortunately, whatever the precautions, seems to be an occasional necessity as applied to man-made things). As to this dirt question, it is yet to be learned how common the examples which have appeared, of ceiling panel heating pipes' streaking of plaster, may become. Actually, the best inhibitors of dirt deposition by heating devices are these: (1) A tight building construction (which not only restrains ingress of dirt but moreover conserves humidity thereby minimizing the ionization of dirt particles which being ionized tend to embed themselves in wall surfaces), together with (2) moderate temperature of the heating medium. Alike these factors promote cleanliness with respect to panel heating or convection heating.

Recalling that I have pointed out in my article that panel heating has the inestimable benefit of the best of modern thermostatic controls, I would like now to call attention to the fact that panel heating has in these recent years also benefited as to cleanliness potential, in being associated with the most modern of construction practices and with the employment, as a rule, of a low temperature heating medium.

Now a word as to factory heating with radiant panels: Of course, the only place to put these is in the floor for if we go back to putting coils overhead we simply turn back the clock several decades to the old pipe coils that were massed along factory ceilings and did a thoroughly ineffective job of inverted-bucket heating of these areas. Assuming then that our panel heating coils must go into the floor, if anywhere in a factory, how do factory (production lay-out) engineers relish the prospect of a grid of water-carrying pipes blanketing practically every square foot of the factory floor area? A modern factory is a mining camp; go into a sizable and active production plant and almost at any time you will find new holes being dug in floors as machines are being relocated, new machines being added, even whole production lines being revamped. Technological acceleration in American factories is at an ever higher tempo and the importance of leaving factory floors clear of underground obstructions to the setting of new machine footings is increasing rather than diminishing.

Apart from this question of interference with flexibility of production equipment re-alignment there are, as I see it, several sound arguments opposing the proper application of panel heating in factories but these remarks should not be continued ad infinitum and further discussion of this point can be reserved for another time.

To get back now before closing to the broader view of the subject: With entire sincerity I agree with Mr. Adlam that there is a place for all forms of heating and I likewise urge that we be tolerant and receptive as respects all methods which seem to deserve our further investigation and development. I would not legislate mentally against attempts to progress. Further, I would say that if those who wish to have panel heating can have the good fortune of having the advisory services of men like Mr. Adlam they are certain to have a good quality of heating result and to obtain an altogether reasonable economic return from their investment.

Editorial

Are We Ready for Annual Shows?

THE wisdom of the decision to hold the International Heating and Ventilating Exposition annually instead of biennially as in the past is being seriously debated by manufacturers who, incidentally, as exhibitors are the ones who finance the show; they, too, know, better than anyone else, the outlook for new equipment on which the success of a show so largely depends. However, in this question are involved not only the interests of the exhibitors, but those of the heating, ventilating and air conditioning industry as a whole.

Arguments in favor of a show in New York in 1948, one year after that in Cleveland, seem to be, first, that attendance will be tapped largely from a different geographical area, and contractors, architects, engineers, and owners in that area will have an opportunity to inspect the very latest in equipment; second, at least a portion of the profits from the show is devoted to research and there is probably little question that this is to the advantage of the industry, and third, that new developments are at such a rapid rate that an annual show is necessary.

On the other hand, those opposed to an annual show are manufacturer exhibitors who point to the high overall cost of exhibiting which ranges from several thousand to twenty thousand dollars or more. The time consumed by their staffs at a show is also a factor, and this time, they feel, could be more profitably employed elsewhere under today's conditions.

The objective of an exposition is *ultimately* to produce sales. This implies an attendance of such quantity and quality that selling profits will be sufficient to offset costs. This attendance depends, in turn, on the rate of development of new equipment. Just where the frequency of exhibitions reaches a point of seriously diminished returns to the exhibitors is unknown, but in the opinion of many manufacturers this would be reached with an annual show. It is significant that the machine tool industry, for example, which depends on new developments, has set four years as the frequency of its principal show.

There has gradually grown up the accepted practice that in the alternate years when no heating and ventilating show was held, at least two individual groups held their own expositions. These included the oil burner group and the refrigerating equipment group, both of which previously scheduled shows for 1948 in Chicago and Cleveland, respectively. Still other exhibitors are in a position where they must display at one or more other annual expositions such as the Power Show, the American Gas Association exposition, and so on.

Manufacturers generally are operating on a small profit margin. Increasing the sales expense by too frequent shows must eventually mean an increase in cost of equipment which will be to the disadvantage of the whole industry and to the public.

In the final analysis the whole question hinges on the profitability of exhibiting. Only the manufacturers themselves are in a position to appraise this and the responsibility is theirs if they support too many shows. Pending more conclusive evidence as to the desirability of a show every year, our own opinion is that developments are not rapid enough, even today, to warrant an annual exposition.

What is the opinion of the exhibitors themselves?

Clifford Strock

Experience is my Classroom

By T. W. REYNOLDS

A BOILER CASE IN COURT

A building owner sued a contractor who put in an oil-fired steam boiler made by one of the largest manufacturers. The job seemed satisfactory and the writer told the owner so; nevertheless the owner insisted on his services in court, because he also had a complaint about damages from water.

The lawyer for the other side (the manufacturer), was one of the best. Upon cross examination he got after the writer in a determined way, but the judge seemed uninterested and lost in reflection. Suddenly, the judge interrupted to ask if a cast iron boiler would crack when dry. The writer could not see what bearing this had on the case before the court, but in a very learned speech set forth as follows: "No, it may warp a bit, but won't crack unless condensate suddenly returns, or the water feed valve is opened to the boiler. This has been demonstrated in the laboratory. The water can be cold or hot, it makes no difference which, any water at all causes a too rapid shrinkage on overheated metal. In normal operation, the temperature of the metal is much lower due to a water-filled boiler." The judge then said, "Thanks, I wanted this for my own information" and everybody had a good laugh. No doubt he had another case which involved a cracked boiler.

Upon cross examination the corporation's lawyer who must have believed in the boiler's ability to do the job and in the writer's veracity suddenly asked, "Is the boiler of proper capacity and its make of high repute." The writer could only answer that it was and felt like asking him what took him so long to reach that question.

There was silence all around for the moment, then the judge called the two opposing lawyers over to him for a whispered conference and said "Why, even the plaintiff's own expert, whom I never saw before, but respect his testimony to a considerable degree, gives the boiler a clean bill of health. As for the water damage, I can see that this was caused by the contractor's negligence." The latter part of his conclusion was on the basis of the writer's previous testimony that the damage by water was most likely done by one of the workmen who had made frequent use of the draw-off at the boiler as a convenient source of hot water. This made necessary an occasional refill of the boiler, but at night when hurrying away the workman was most likely to forget to close the feed valve to the boiler.

Acceptance of this conclusion was fast work upon the part of a judge to settle a case quickly. Evidently, he had sized the situation up, as follows: The corporation would be satisfied with the boiler held blameless. They were in reality only defending the boiler and not the contractor who would be left to pay the water damage. As to the owner, he would get some redress for the damage done by water to decorations.

As to the writer, he was mystified a bit, for as a rule testimony of this kind is not good legal evidence. The one testifying (the writer) was not present at the time of the damage, and the action could, of course, have been caused by most anybody around, while the testimony itself was only based on a probability and was so stated. All this happened many years ago, but the writer is still pondering over that sudden finish.

COMFORT vs. ECONOMY

The writer has gone to court as a witness on some jobs where the owners complained that they could not set their thermostats at 70F and get that temperature at all points in the house. In a certain measure the owner is right. Why should he set the thermostat at say 70F or 80F in order to get 70F on the second floor, or else go around turning off radiators. To that extent our heating systems still lack perfection.

At one time the writer hired a lawyer, or lets say "retained an attorney," for his fee was that high. Later on the lawyer himself got into trouble, all over the thermostat location for the gas-fired boiler in his home. Just because of this, he was going to take out the gas and put in oil, and charge it all up to the contractor. It seems that the lawyer wanted the thermostat located where he could heat the room he occupied the most, even though such location would cause overheating of most of the other rooms. He had the means, wanted comfort first, economy second. The gas company put economy first as necessary with an expensive fuel.

This is where the writer came in, but found in the end that the time involved as a witness was three times as great as the time the lawyer had spent on the writer's own case and that the fee received was only one-third of the lawyer's fee. If the writer paid the lawyer $100 what did the writer get for the same hours as the lawyer worked?

TROUBLE SHOOTING

Trouble hunting becomes an art in time. When you arrive at a problem, everyone follows you around, expecting you to take one glance, then pull a rabbit out of your hat. The children and dog get under your feet and the housewife brings down tea for a talk. If you are smart you let them wear themselves out. Getting accustomed to your presence they soon wander off to more interesting pursuits. Meanwhile, you do a lot of meaningless things, open the firing door and look within, they all do the same and see nothing, the same as you see. Then you rattle the grates and so on, until you are by yourself and can get to work and think.

Trouble hunting also has its humorous side. Which reminds the writer of the time he was shown around the spacious mansion and servants quarters of Eugene Meyer at Mt. Kisco, N. Y., by one of the family. Coming to an inspection of the radiators in one room, this member of the family expressed surprise and said he never knew that such a room was there before.

An unusual story is concerned with a large tank which had to go over a small draw bridge to an estate on an island. The tank came to rest on one end of the bridge as it was found too large to pass the upright sides of the bridge.

The engineers debated the problem. The tender of the bridge listened for a time, then offered to take it across for $50. The offer was jokingly accepted. So the tender piled enough stone on the other end of the bridge to balance the weight of the tank, swung the bridge around through a half circle, and the tank was at the other shore.

Note: Mr. Reynolds is Chief, Air Conditioning Division, Abbott, Merkt & Co., Engineers, New York.

ENTRANCE VIA STACK

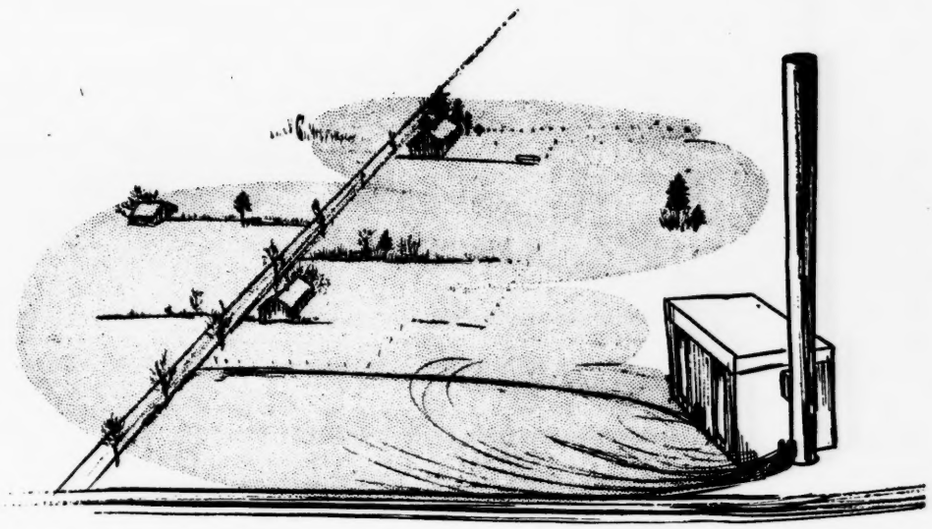
Along about the time of World War I, the writer was in the employ of the New York Central Railroad. The last draft caught up with him, but this was duly protested by the railroad as their employes were considered indispensable to the war effort. How much so they were in the writer's case, the reader may judge for himself, for his work had only to do with an appraisal of mechanical facilities for purposes of rate making in accordance with rulings of the Interstate Commerce Commission. So the writer travelled for three years with his trunk as a home and got so he could sleep well only in a Pullman berth. The responsibility was as leader of an engineering squad, all of us young, full of adventure, carefree and equally as careless.

Up near Lake Placid, N. Y., the railroad had an occasionally-used pump house, locked at other times, and with the key kept many miles away at maintenance headquarters for the division. One of our men, a Mr. Bird, was truly named; he could pick locks or climb anything, having climbed many a mast while in the Navy.

The pump house was locked with a lock that could not be picked. Nothing daunted, Bird went up to the roof and then dropped down inside the short stack to the top of the vertical fire-tube boiler.

He knew that the base of such stacks had an access door for soot cleaning at the point where the base rested on the boiler top. Once inside he figured on inserting a blade of his knife to open the latch of the access door, after which it would be a simple matter to climb out of the boiler and open a window to those outside. Sad to relate, the access door had jammed too tight for a mere knife blade to

open, so he couldn't get out either by the door or by climbing up the stack. This is where we came in so we smashed a window, entered and released him, but first let him worry a bit, because he had wanted so much to show us how.



CHIMNEY CLEANING

At one time, our party had temporary headquarters in the railroad station at Utica, N. Y. for appraisal of railroad property in that vicinity, particularly within the roundhouse not far away. In the course of the appraisal we came to the tall chimney exterior to the power house. Wanting, as heretofore, the inside information, the writer opened up the cleanout door. It was a beautiful scene with the snow lying white all around, but only for a moment, for out the door came a flow of soot accumulated from the base to the breeching and backed up by a static head equal to that from door to breeching away overhead.

For a moment the writer was buried under the soot slide and then the local strong winds picked the soot up and the snow went black for a few acres around. The engineer came out to see what had happened to his draft, expecting to find the old breeching gone, and found the writer black from head to foot and spitting soot. He closed the cleanout and wrote in his report "Cleaned out the chimney today." . .

BOILER RATINGS

The performance of a boiler is dependent upon adequate draft, boiler flues and water reasonably clean, fuel of reasonable quality and an attendant of reasonable intelligence, at least upon the matter in hand. Local fuels must be taken into account. The attendant must also give the boiler the quality and frequency of attention required. All of these conditions are obtained in the laboratory, but in residences the attention is least skillful and least frequent. As a rule, attention is increased as the size of boiler increases.

Ashes should be shaken down whenever fresh fuel is fired, so that there is no melted ash (clinkers) to prevent air from contacting the fuel. Ashes should be removed from the pit daily and never allowed to pile up near the grates so that air cannot pass through them. Grate bars also burn out or warp where there is no air to keep them cool. Warped bars do not revolve properly and cause wide gaps through which coal passes to the pit. These things, do not happen in the laboratory where boiler ratings are made.

SHOW WINDOW VENTILATION

Ventilation of show windows in stores is not a difficult problem, once the heat load from their lights has been determined. As a rule, there are two continuous rows of 150-watt lamps along the windows, on 18 inch centers, with never more than 75% of the lights on at a time. In addition to these lights there are usually two 250 watt spot lights to a window about 30 ft. long.

The temperature of air within the window space should be kept down to 100F by drawing in throw away air at a temperature of, say, 80F from the conditioned store space. This air picks up the heat within the window space and is discharged outdoors by exhaust fans usually at several points over the marquees.

The amount of air required is computed as follows: $(2 \text{ rows} \times 150 \text{ watts} \times 75\%)/1.5 \text{ ft} + \frac{2 \text{ lamps} \times 250 \text{ watts}}{30 \text{ lineal feet}} =$ 167 watts per lineal foot of window. Hence,

$$\frac{167 \text{ watts} \times 3.4 \text{ Btu per watt}}{.018 \times (100\text{F} - 80\text{F}) \times 60} = 26.3$$

cfm per lineal foot of window.

As this is not a large quantity of air to handle, the writer likes to design for 250 watts per lineal foot and this will require 40 cfm per lineal foot of window.

This larger quantity has the further advantage of providing a factor of safety, thus eliminating the need for thermostatic control to hold the space down to 100F. If the make-up air were from outdoors at 95F, the required air quantity would rise from 40 to a minimum of 50 cfm, if thermostatically controlled.

NEWS OF EQUIPMENT AND MATERIALS

Leak Detector

NAME — Leak detector for vacuum systems.

PURPOSE—Sensitive instrument for locating and detecting leaks in vacuum systems.

FEATURES—Makers claim that this portable battery instrument can register a leak as small as the equivalent of .006 in. of water. Such a leak causes a ⅛-in. deflection of the needle on the scale. Instrument is furnished with a short tube having a rubber suction cup on the end to be applied at the point of detection. When the suction cup covers a leak the needle on the meter rises. Operation of the instrument is based on the use of a heated wire in a metal chamber as part of a Wheatstone Bridge circuit. When a vacuum is pulled on the chamber, the filament becomes slightly chilled upsetting the balance of the Wheatstone Bridge and causing the needle to rise on the meter scale.

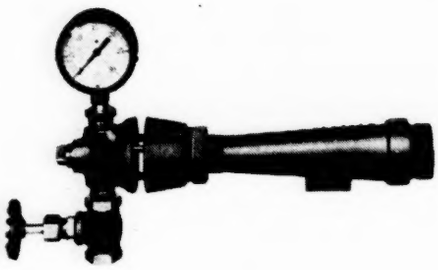
MADE BY—*Davis Emergency Equipment Co., Inc., 202 Halleck St., Newark 4, N. J.* **382**

Gas Mixer

NAME—Bryant Hijector high pressure gas mixer.

PURPOSE—Venturi mixer for high pressure gases.

FEATURES — Unit uses gas under pressures up to 35 lb to entrain all the air needed for combustion and this mixture is delivered to burners at the highest possible pressure. Makers claim that air entrainment noise is reduced while the orifice and air entrainment areas are readily accessible for inspection or cleaning.



SIZES AND CAPACITIES — Available in pipe sizes from ¾ to 4 in. and for all types of gases.

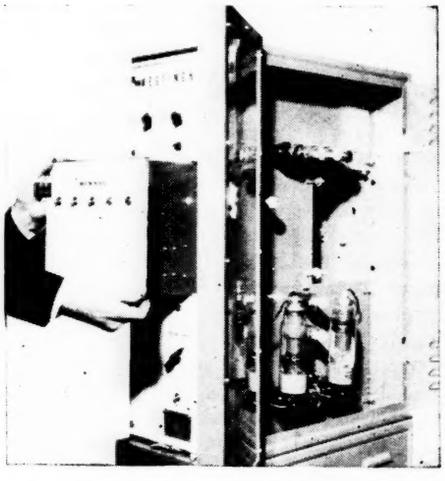
MADE BY—*The Bryant Heater Co., 17825 St. Clair Ave., Cleveland, Ohio.* **383**

Welding Control

NAME—Weld-O-Timer.

PURPOSE—For sequencing and timing operations in welding.

FEATURES—Finger tip control permits increased production speed. Voltage regulator tubes are incorporated in timing circuits to give better timing when connected to welder supply circuits. Inspection of sub-assemblies is simplified through a front access door. Timer can be mounted on the side of the welder or at a place away from welder with adjustment controls at the welder.



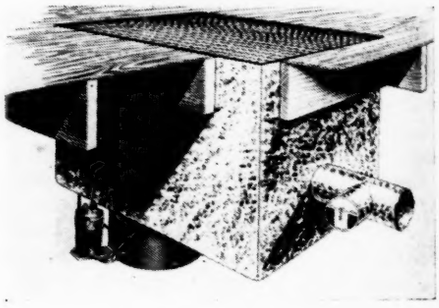
SIZES AND CAPACITIES — Made in two frame sizes. Delivered in factory assembled package.

MADE BY — *Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.* **384**

Floor Furnace

NAME—Gillen oil-burning floor furnace.

PURPOSE — Heating unit designed for small home installations.



FEATURES — Furnace is equipped with a burner that operates on low natural draft. Complete installation of the furnace is said to require few alterations to existing home structure. Furnace operates on No. 1 fuel oil or kerosene and has an output of 50,000 Btu. Maximum oil flow is set at ¼ gal per hr with a pilot flow rate of 4cc of oil per min.

MADE BY—*J. L. Gillen Co., Dowagiac, Mich.* **385**

Welding Electrode

NAME—SW-16 welding electrode.

PURPOSE—Electrode for light gauge sheet metal welding.

FEATURES—New electrode is for all position welding on light gauge mild steel. Makers claim it will weld with a minimum build up and produce a bead contour that requires little finish grinding.

MADE BY—*A. O. Smith Corp., Milwaukee, Wis.* **386**

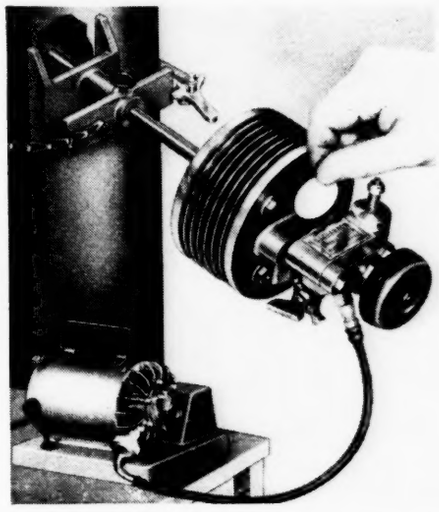
Electric Heater

NAME—Thermador.
PURPOSE—Vertical heater for bathroom.
FEATURES — Heating unit is of nickel chromium held in place by special porcelain bushings and nichrome pins. Heater is 4 ft high by 9 in. wide with a switch located on top of the grille. Unit, does not require any vents, flues or pipes.
SIZES AND CAPACITIES — Three models with power consumption from 1650 to 2000 watts.

LITERATURE AVAILABLE—Illustrated folder.
MADE BY — *Thermador Electrical Manufacturing Co., 5119 District Blvd., Los Angeles 22, Calif.*.....**387**

Smoke Tester

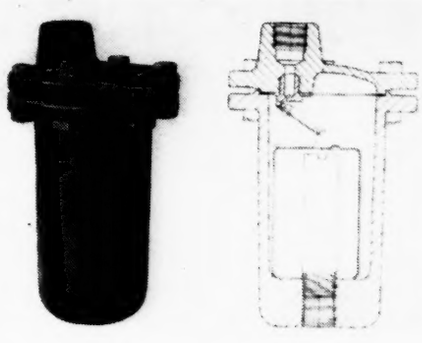
NAME—Bacharach smoke tester.
PURPOSE—For evaluating the density of smoke from a combustion process.
FEATURES—Tester consists of a sampling unit attached to the smoke pipe of the oil burning furnace, and a motor driven vacuum pump which may be set at any convenient place near the furnace. A time switch mounted on a motor base automatically stops the operation of the motor after a 1-min. interval.
OPERATION — Sampling tube is inserted into the flue pipe through a 7/16-in. hole between the furnace outlet and the barometric draft



regulator. The electric cord of the vacuum pump is plugged into the nearest 110 volt a-c outlet and a small filter disc inserted in the filter holder of the sampling unit. A turn of the handwheel at the end of this unit closes the filter holder and holds the disc firmly in position. When switch is operating vacuum pump draws flue gas through the filter disc for 1 min. at controlled vacuum and the visual indication on the disc serves as a gauge of the smoke density.
MADE BY—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh 8, Pa.* **388**

Steam Trap

NAME — Armstrong forged steel steam trap.
PURPOSE — For general use as a steam trap for service on pressures up to 250 lb per sq in.



FEATURES—Body and cap are steel forged. All of the internal operating mechanisms, including valve seat, are stainless steel. Forged steel construction is said to make the trap resistant to impacts that would shatter ordinary castings.
SIZES AND CAPACITIES—Trap measures 4¼ in. in diameter at the cap with an over-all height of 7 in. Capacity averages 900 lb of condensate per hour, continuous discharge.
MADE BY — *Armstrong Machine Works, 846 Maple St., Three Rivers, Mich.* **389**

Rotary Hand Pump

NAME—Bowser rotary hand pump.
PURPOSE — For use where small hand capacity pump is desired.
FEATURES — Pump is of the vane

type with an aluminum rotor and graphite carbon vanes. Suction and discharge ports are threaded for ¾-in. iron pipe. With normal cranking speed, pump delivers 10 gpm.
MADE BY — *Industrial Pump Div., Bowser, Inc., Ft. Wayne, Ind.*..**390**

Welding Electrode

NAME—DH-MO electrode.
PURPOSE — For welding low alloy cast steel or low alloy high tensile strength rolled steel in a flat position.
FEATURES — Electrode is designed for high speed welding of grooved joints, positioned and horizontal fillets. Electrode is available in four diameters from 5/32 to ¼ in.
MADE BY — *Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.* **391**

Thickness Gauge

NAME—Audigage.
PURPOSE—Portable instrument for measuring from one side the thickness of many materials including steel.
FEATURES — Instrument utilizes a crystal-type gauge head powered by a frequency-modulated electronic oscillator. When the vibrating crystal is applied to a wall surface, mechanical resonance of the wall thickness can be produced directly below the crystal. Fundamental frequency at which the wall section will resonate is directly proportional to the velocity of the sound in the material and inversely proportional to thickness. Character of the audible indications varies with factors such as kind of material, condition of reflecting surface, and so on. Device can be applied to

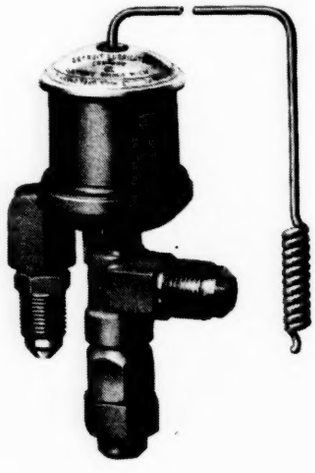
steel, aluminum, brass, copper, glass and other materials. Battery operated instrument is direct reading.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY — *Branson Instruments, Inc., Danbury, Conn.* **392**

Refractory Cement

NAME—Armstrong Air Set.
PURPOSE—A cold setting refractory cement for use as a bonding mortar with fire brick and for insulating fire brick.
FEATURES — Cement can be trowelled directly from the drum even after considerable storage of material. It can be thinned with water to dip joint or facing consistency. Makers claim that the cement will not soften or run out of the joints. Cement is shipped in steel drums of 16, 50, 95 and 185 lb capacity.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY — *Armstrong Cork Co., Lancaster, Pa.* **393**

Expansion Valve

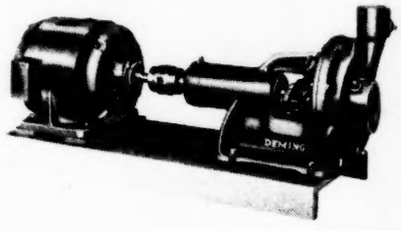
NAME — Detroit No. 573 thermostatic expansion valve.
PURPOSE—For use with small com-



mercial refrigeration systems—½ ton (Freon-12) capacity.
FEATURES—Double diaphragm construction makes possible close superheat control at low suction pressures. The two-diaphragm gas charged power element provides motor overload protection using only one power element.
LITERATURE AVAILABLE — Catalog No. 200-B.
MADE BY—*Detroit Lubricator Co., 5900 Trumbull Ave., Detroit 8, Mich.* **394**

Centrifugal Pump

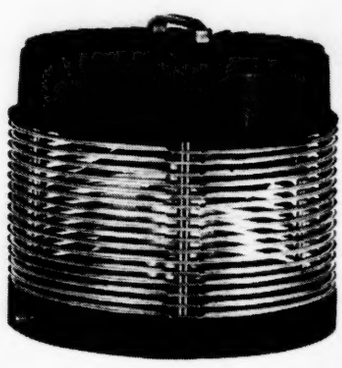
NAME—Deming side suction centrifugal pump.
PURPOSE—Pumping of fluids.
FEATURES—Pumps are made in three types — single ball-bearing with open type impeller, two ball-bearing with open type impeller, and two ball-bearing with semi-enclosed impeller. Each is made for belt drive or for direct connection to electric motor.
SIZES AND CAPACITIES—½, ¾, 1, 1½ and 2 in. side suction with capacities ranging from 2 to 2000 gpm.



LITERATURE AVAILABLE — Bulletin 3900-B.
MADE BY—*The Deming Company, Salem, Ohio.* **395**

Air Distributor

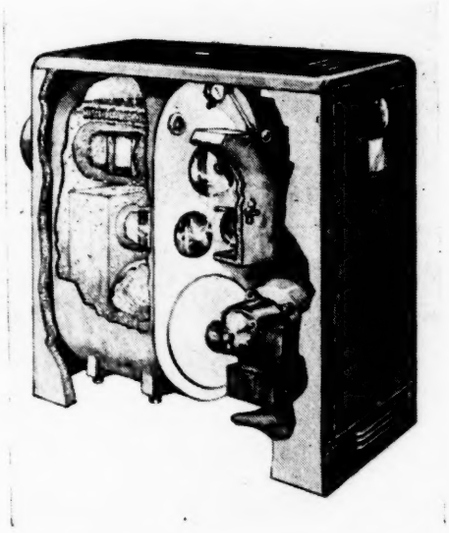
NAME—Motionair.
PURPOSE—Indirect air circulation.
FEATURES—Unit is made of die cast aluminum and is powered by 1/15 hp electric motor. Handle at top



permits carrying unit from room to room. At the base of the unit is a two-speed switch. Air at floor level comes in contact with the 12 in. fan blade and is forced out through louvers in an upward line. Air strikes the ceiling and then mushrooms out. Unit weighs 20 lb.
MADE BY — *Motionair, Inc., Dept. HV, 3321 E. Slauson Blvd., Los Angeles 11, Calif.* **396**

Boiler

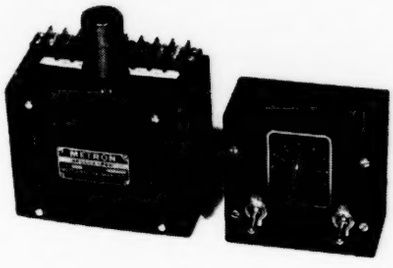
NAME—Crotty heat generator V-R.
PURPOSE — Space heating for the one-family house.
FEATURES—Unit is Scotch Marine



wet base type. Boiler may be fired with oil, gas or used in connection with automatic stokers. Adjustable deflectors direct passage of gases and compensate for any condition of poor chimney draft. Flues clean from the top down without the necessity of opening the jacket. Boiler constructed of steel in accordance with ASME standards.
MADE BY — *Crotty Boiler Corporation, 60 East 42nd St., New York 17, N. Y.* **397**

Welding Timers

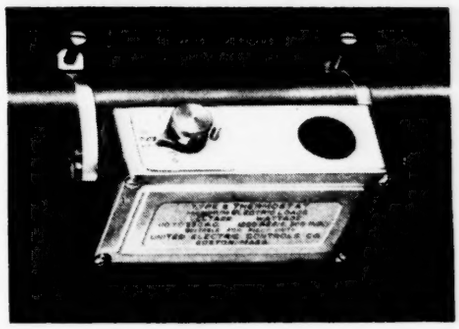
NAME—Metron welding and industrial timer.
PURPOSE—For industrial timing.
FEATURES — Control box measures



4 x 4 x 2 in. and can be incorporated in a machine by flush mounting near the operator with a timer box mounted out of the way. Control box can be attached to the timer box for mounting as an integral unit. Timing intervals are from 1/60 sec. up to several minutes and can be provided in one or several continuously variable ranges.
MADE BY—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*...**398**

Thermostat

NAME — Type S strap-on thermostat.
PURPOSE—For controlling temperatures of water, steam, and other fluids.
FEATURES—Bi-metal thermal assembly is actuated through heat



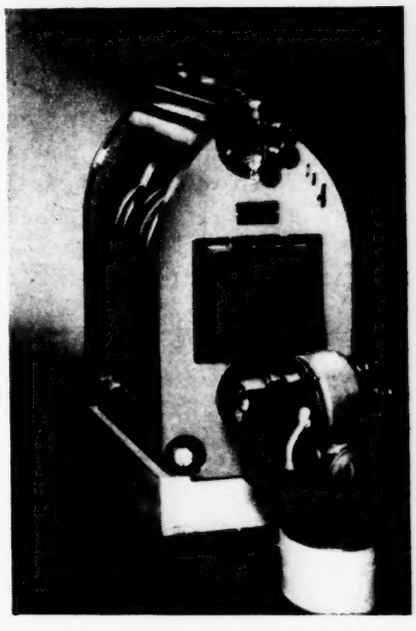
transferred by the rear thermostat housing. Dial adjustment is calibrated from 40 to 210F. Voltage rating is from 110 to 220 a-c. Adjustable clamps permit mounting thermostat on a wide variety of pipe diameters. Housing is tapped to receive standard electrical connections. Three types of switch action are available: Normally closed, makes on falling temperature; normally open, breaks on falling temperature; and double throw, one side normally closed, one side normally open, no neutral position.
MADE BY—*United Electric Controls Company, 69-71 A Street, Boston 27, Mass.* **399**

Corrosion Inhibitor

NAME—Morpholine.
PURPOSE—For treating feed water to check corrosion.
FEATURES—Chemical is a volatile compound that inhibits corrosion that results from carbon dioxide in steam and condensate return lines of steam heating or processing systems. Material is an alkali that controls acidity due to free carbon dioxide in the feed water or carbon dioxide resulting from decomposition of soluble carbonates. Compound evaporates with the water in definite proportions so that any desired alkaline value can be maintained by adjusting the concentration in the boiler.
MADE BY—*Carbide and Carbon Chemicals Corp., 30 E. 42nd St., New York 17, N. Y.*.....**400**

Boiler

NAME—Rutledge steel water tube boiler.
PURPOSE—Space heating.
FEATURES — Makers claim that a patented design makes it possible to expose all the inside heating area to the flame so that high heating capacity is obtained in a small size



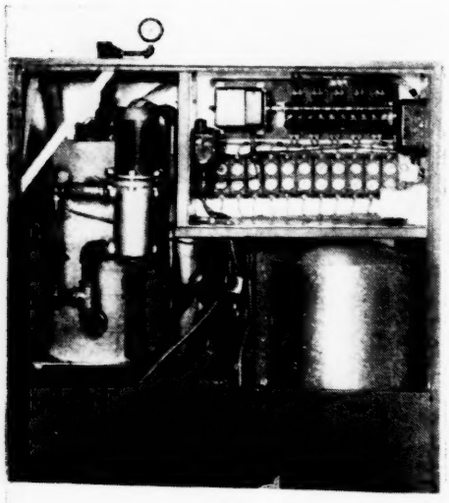
unit. All boilers are provided with a 2½-in. domestic hot water connection in the top steam drum of the boiler.
SIZES AND CAPACITIES—Square feet EDR rating for steam boilers range from 206 to 2499 and for hot water from 489 to 3998.
MADE BY—*Rutledge Boiler Co., Morganton, N. C.* **401**

Electric Steam Generator

NAME — Cronholm Vap-O-Lec electric steam generator.

PURPOSE—For the rapid generation of steam using electric power.

FEATURES—Makers claim that 100 lb steam pressure is available 3 minutes after the switch is turned



on. Operating pressures of from 5 to 100 lb are possible by adjusting the pressure control. Small steam generator has a series of copper sheathed immersion electric elements extending through it. A control allows only the necessary amount of energy to enter the generator to produce the desired amount of steam. Floor space required is 8 sq ft. Unit stands 3.5 ft high.

SIZES AND CAPACITIES — Units of 18, 30, 45 and 60 kw are available or boiler horsepower ratings of 1.7, 2.9, 4.1 and 5.4.

LITERATURE AVAILABLE—Illustrated folder.

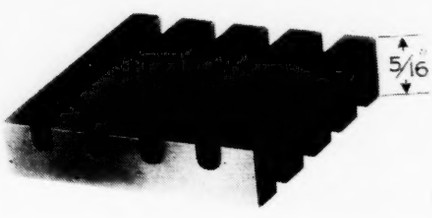
MADE BY—*The Cronholm Mfg. Co., 3500 S. E. Hawthorne Ave., Portland 15, Ore.* **402**

Vibration Pad

NAME—MB Isomode.

PURPOSE — Means for isolating vibration in machinery, and for reducing noise.

FEATURES — Pads are made of Neoprene, compounded to insure long life. Pad is said to absorb the impact, reduce noise, and hold the machine in place. Standard size



pads are 18 in. square and 5/16 in. thick and can be cut to any size or shape desired.

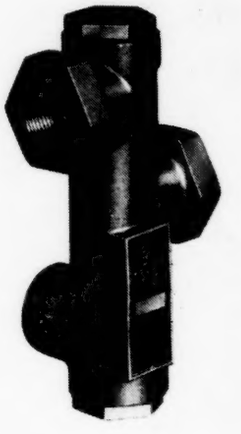
MADE BY—*The MB Manufacturing Co., Inc., 1060 State St., New Haven 11, Conn.* **403**

Coil Cleaner

NAME—B & G Clean-A-Coil valve.

PURPOSE—To keep heater coils free from sediment and lime.

FEATURES—When faucets are closed, water circulates from the heater to the tank and back to the heater. When a hot water faucet is opened, valve causes the water to reverse its usual direction of flow. Cold water enters the valve, flows through the heater in the direction opposite of the normal flow. Back wash flow is more turbulent than the heating



cycle flow, and scrubbing action is said to clean out sediment. Where the temperature differential between incoming cold water and the hot water in the heater is great enough, a de-liming process occurs.

MADE BY—*Bell & Gossett Co., 8200 Austin Avenue, Morton Grove, Illinois.* **404**

Paint

NAME—Prepaint.

PURPOSE — For applying to aluminum and its alloys that are to be painted or lacquered in high production work.

FEATURES—Paint is applied at room temperature by dip, spray or brush and reacts chemically so that with a single chemical treatment makers claim there is a bond with the aluminum surfaces in from 15 to 60 seconds. Paint is non-flammable and non-toxic, and is shipped in 55-gal steel drums.

MADE BY—*Technical Processes Div., Colonial Alloys Co., Bridge Ave. and Crawford St., Philadelphia 29, Pa.* **405**

APRIL, 1947

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below, circle the item number of the equipment in which you are interested, using the number found at the end of each item.

382	383	384	385	386	387	388	389
390	391	392	393	394	395	396	397
398	399	400	401	402	403	404	405

Print your name and address, detach and mail to

Editor, HEATING AND VENTILATING, 148 Lafayette St., New York 13, N. Y.

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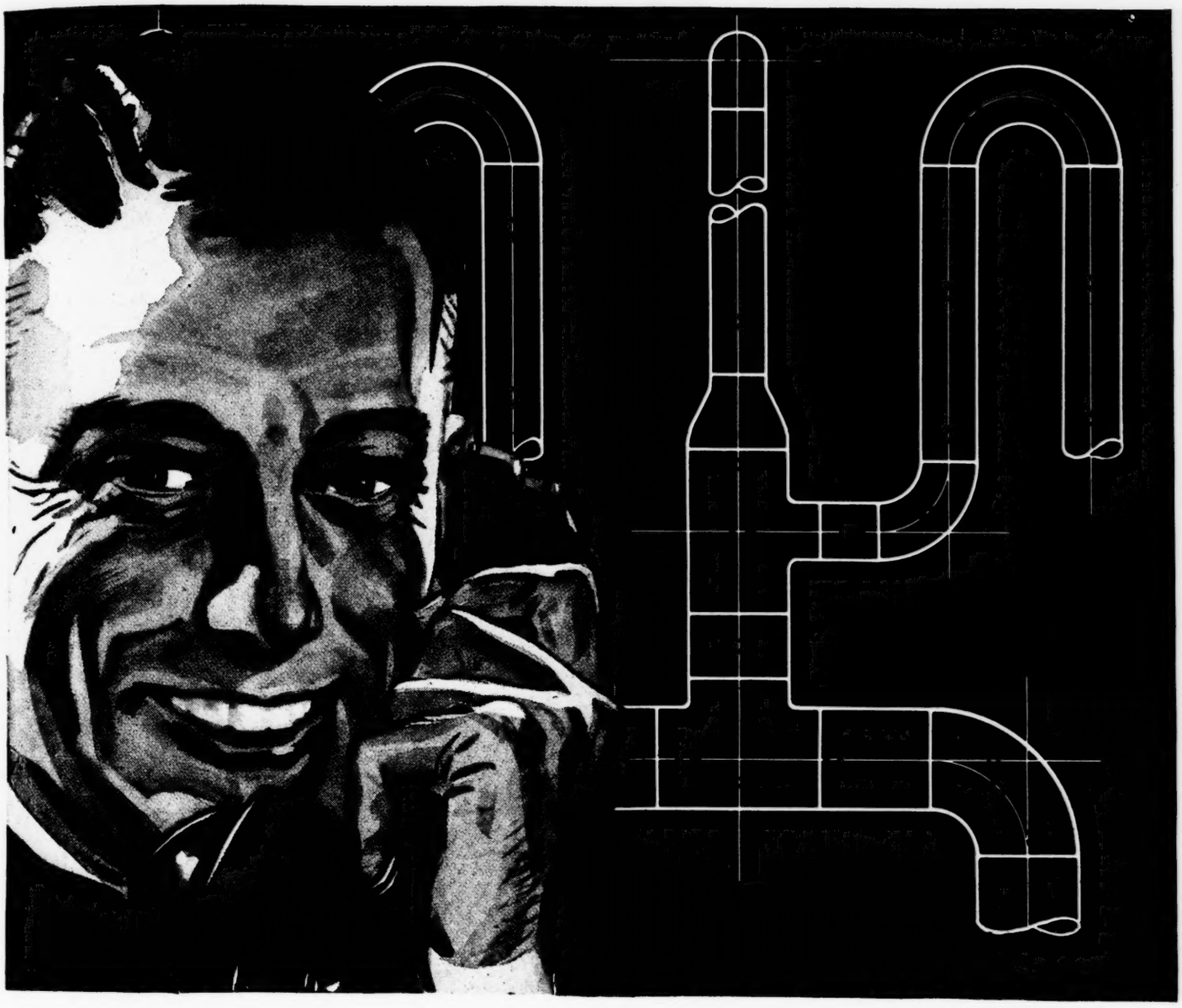

"3½% Nickel? – Yes Sir!"

MODERN piping engineering calls for the use of more and more special steels and alloys in welded lines. Demands for welding fittings to meet these new requirements are being filled more and more promptly thru the Tube Turns distributor.

He represents a really complete line of welding fittings, and flanges. A line which includes more than 4000 items in carbon steel and also a wide range of special metals and alloys—stainless steel, wrought iron, copper, aluminum, monel metal, inconel, nickel, carbon moly, chrome moly, brass.

Write for the name of your nearest Tube Turns distributor and facts about how *the fittings that become part of the pipe* serve others in your industry.

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ONE SOURCE OF SUPPLY FOR ALL WELDING FITTING REQUIREMENTS

NEWS OF THE MONTH

I.L.O. VENTILATION CODE

reviewed by U. S. experts in step toward setting up international guide for industrial environment control.

A distinctive contribution toward meeting this Government's increased international commitments was made on February 25 and 26 when the U. S. Department of Labor invited the Nation's outstanding authorities in the field of industrial ventilation to review a proposed exhaust ventilation code drafted by the International Labor Organization. When ultimately adopted by an I.L.O. Conference which is composed of employer, worker and government representatives from 57 countries, the code will be transmitted to the governments of those countries as a guide to the protection of workers against the hazards of industrial dusts, fumes, gases, and vapors.

Meeting at the invitation of the Labor Department's Division of Labor Standards in Washington, 15 outstanding American ventilation engineers and industrial hygiene engineering authorities completed a review of the recommended draft code incorporating accepted techniques, designs, and methods for the engineering control of these work hazards.

• **BEST MINDS.**—David A. Morse, Assistant Secretary of Labor, commended the group for their generous cooperation and pointed out that this was the first time the best and most interested minds had assembled to confer on such an important international problem. It is desirable, he stated, to enter international code preparation in an early phase. He stressed the importance to American industry and labor of bringing world labor standards in line with the best practices so that neither may suffer from unfair international competition or sub-standard working conditions.

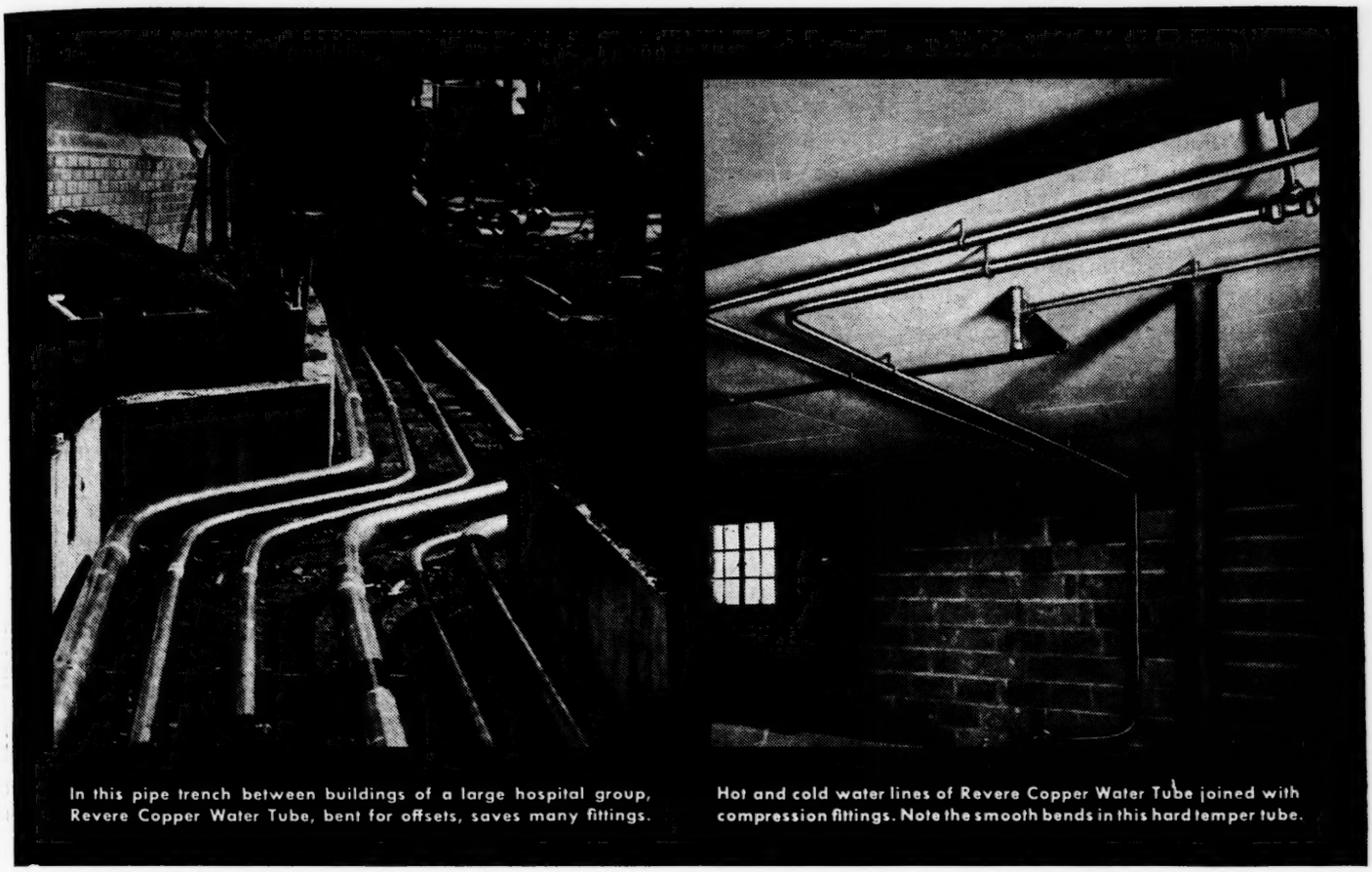
• **DEVELOPMENT.**—The proposed code was originally compiled by a member of the I.L.O. Committee on Accident Prevention from various existing American codes with consideration given to British and European viewpoints. Ventilation authorities in other lands also are making their comments and suggestions. All comments will be reviewed by the I.L.O. committee next August in Montreal and a final draft prepared for the Governing Body, as the I.L.O.'s executive board is called. The Governing Body will schedule the code for consideration at a subsequent I.L.O. conference as a draft convention or treaty.

The discussions of the American authorities on the code will be made available upon request to interested parties by the Division of Labor Standards.

• **PEOPLE.**—Presiding over the meeting of American authorities in Washington was W. N. Witheridge, ventilation consultant, Industrial Hygiene Department, General Motors, Detroit, Mich.

The meeting was attended by Cyril Ainsworth, assistant secretary and D. F. Hayes, safety engineer, American Standards Association, New York, N. Y.; Allen D. Brandt, industrial hygiene engineer, Bethlehem Steel Co., Bethlehem, Pa.; Richard L. Higgins, chief safety engineer, Department of Labor of New Jersey, Trenton, N. J.; John M. Kane, chief engineer, Dust Control Division, American Air Filter Company, Louisville, Ky.; Swen Kjaer, industrial safety consultant, I.L.O. Committee member, Washington, D. C.; George W. McCormick, Jr., Propellor Fan Manufacturers Association, Detroit, Mich.; Benjamin F. Postman, industrial hygiene engineer, Employers Mutual Liability Insurance Co., Wausau, Wis.; W. N. Witheridge, ventilation consultant, Industrial Hygiene Department, General Motors Corp., Detroit, Mich.; Warren Watson, Manufacturing Chemists Association, Washington, D. C.; William Harris, engineer, Industrial Hygiene Division, New York State Department of Labor, New York, N. Y.; W. O. Vedder, manager, Dust Control Department, Pangborn Corp., Hagerstown, Md.

U. S. Department of Labor, Division of Labor Standards, I.L.O. Exhaust Ventilation Code Conference, Washington, D. C., February 25 and 26, 1947. Reading from left to right: R. L. Higgins, Cyril Ainsworth, D. F. Hayes, Dr. Allen Brandt, S. C. Rothmann, W. G. Marks, W. N. Witheridge, William Harris, John Kane, W. O. Vedder, Swen Kjaer, and Benjamin F. Postman.



In this pipe trench between buildings of a large hospital group, Revere Copper Water Tube, bent for offsets, saves many fittings.

Hot and cold water lines of Revere Copper Water Tube joined with compression fittings. Note the smooth bends in this hard temper tube.

TROUBLE always costs more than

REVERE COPPER WATER TUBE

THE permanently smooth interior of Revere Copper Water Tube permits full and unrestricted flow of water, oil or gas for a lifetime of continuous service. Due to the long life of copper, this tube guards against leaks, rusty tap water, inadequate flow and faulty circulation. Yet, completely installed, it costs little or no more in the first place . . . and much less in the long run. Remember—*trouble always costs more than Revere Copper Water Tube!*

Revere Copper Water Tube is ideal for heating, water supply, air conditioning and other services — underground or indoors—in all kinds and sizes of buildings. Joints are easily made with either soldered or compression fittings. The soft temper Type K and Type L tubes in all sizes, and even the hard temper Type K tube in sizes up to 1″ inclusive, are easy to bend, thus eliminating many fittings and reducing frictional resistance in the piping system.

Revere Copper Water Tube is stamped at regular intervals with the Revere name and the type. Look for these identification marks—they insure full wall thickness and the close gauge tolerances so essential for tight sweated joints.

You can specify or install, in addition to Revere Copper Water Tube, such other long-lived Revere materials as Red-Brass Pipe; Sheet Copper and Sheet Herculoy for tanks, ducts, pans and trays; Dryseal Copper Refrigeration Tube (dehydrated and sealed); Copper oil burner, heat control and capillary tubes.

The Revere Technical Advisory Service, Architectural, is always ready to serve you. Call your Revere distributor.

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Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

Members of the Department of Labor attending the session were: Assistant Secretary David A. Morse; William L. Connolly, director of the Division of Labor Standards; Clara M. Beyer, associate director of the division; William G. Marks, chief of the safety and health branch; R. P. Blake, principal safety engineer; and S. C. Rothmann, industrial hygiene engineer.

In addition to the committee members, the following individuals reviewed the proposed code:

Theodore Hatch, Industrial Hygiene Foundation of America, Pittsburgh, Pa.; A. B. Epple, assistant professor, Department of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.; G. L. Tuve, professor of mechanical engineering, Department of Mechanical Engineering, Case School of Applied Science, Cleveland, Ohio; A. P. Kratz, Department of Mechanical Engineering, University of Illinois, Urbana, Ill.; S. Konzo, special research professor, Department of Mechanical Engineering, University of Illinois; and Roy P. Warren, Air Cleaning Department, Buffalo Forge Co., Buffalo, N. Y.

COAL INTO FLUID

by chemical manufacture of gas, oil, and alcohol is goal of world's largest coal producer.

Plans to convert coal into fluid fuels on a gigantic scale were revealed as the Pittsburgh Consolidation Coal Co., announced it would start construction of a $300,000 experimental plant near Pittsburgh for the conversion of coal to gas, gasoline, Diesel and fuel oils, and industrial alcohol. Successful operation of this plant is to be followed by construction of a giant gasification and liquification plant costing $120 million. Cooperating in the project will be Standard Oil of N. J.

• **SIZE.**—Pittsburgh Consolidation owns 500 million tons of unmined coal within 25 miles of Pittsburgh and operates 43 mines in four states. The commercial plant will consume 6 million tons of coal and will yield 96 billion cubic feet of gas a year. It will produce 114 million gallons of gasoline, 14 million gallons of fuel oil, and 8 million gallons of alcohol a year.

• **TWO STEPS.**—Conversion of coal to fluid will be accomplished in two basic steps. First, production of carbon monoxide and hydrogen, a mixture called synthesis gas; second, processing of synthesis gas in a hydrocarbon plant and separating the high-heat, fluid fuels produced. Know-how for the second step will be supplied by Standard Oil with wrinkles to be ironed out by experience at the pilot plant.

FUTURE FOR OIL BURNERS

described at convention of Oil Heat Institute held at Atlantic City, N. J.

Based on current estimates, it is expected that by 1955, there will be 6,200,000 domestic oil burners and 740,000 commercial oil burners in use—the former will burn 250,000,000 barrels of distillate petroleum products during 1955 and the industrial type will consume 90,000,000 barrels for heating purposes only. These figures were presented by Dr. A. B. Hersberger of Atlantic Refining Co., Philadelphia, Pa., at the twenty-fourth annual convention of the Oil Heat Institute held at the Hotel Traymore, Atlantic City, N. J., March 24-26.

Another estimate of the size of the oil burner industry was made by W. A. Matheson, Executive Vice-president, Eureka Williams Corp., and president of OHI. He stated that at present 3,000,000 homes are employing oil heat. In 1920, this total was but 12,500.

• **SHORTAGES.**—At one time oil heat installations were hampered by the shortage of motors which held up the production of oil burners. Now, because of the shortage of steel, inside and outside oil storage tanks are difficult to obtain and oil-burning installations cannot be completed. The industry is also worried about the fact that in contrast to the coal purchaser who stores a supply of coal for the entire heating season, the oil user, buys his oil in small lots. When steel is less restricted, it is hoped to educate the customer to the fact that additional fuel storage capacity should be provided.

• **ENGINEERING.**—An Engineering Session was held on Tuesday afternoon with F. H. Faust, commercial engineer, air conditioning department, General Electric Co., as chairman.

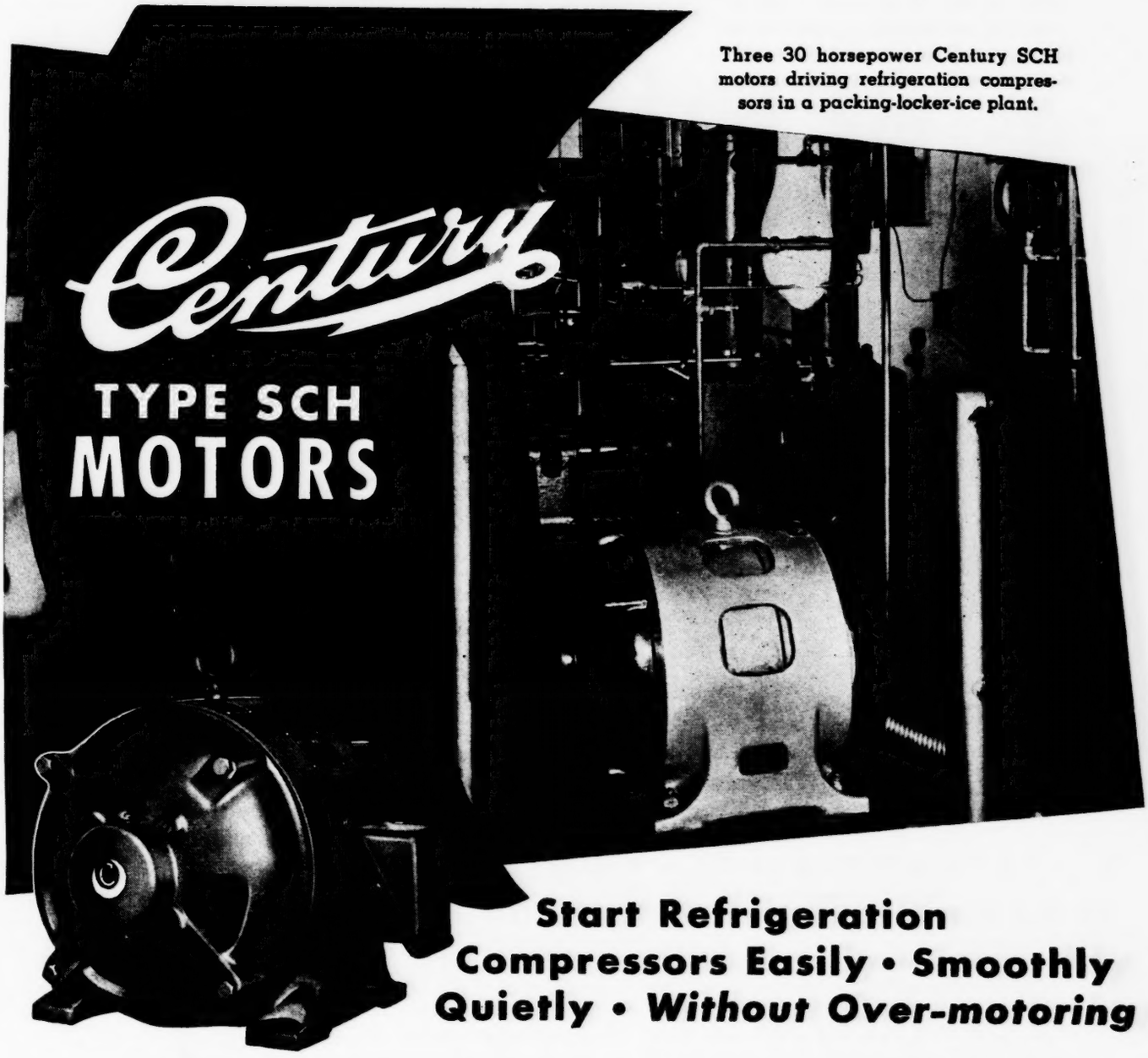
G. T. Kaufman, technical secretary, OHI, spoke on The Institute and its Technical Activities. He described a testing unit that had been developed under the auspices of the institute, which is to be placed in operation by a laboratory to be selected. The unit which consists of a refractory lined cylinder with one end arranged so that it can be moved horizontally like a piston, is designed to burn various types of oils. Since the smoking tendency of burners can be considered as a common yardstick, a photoelectric arrangement is used in the pipe carrying off the products of combustion, to measure the smoke density. The purpose of this test unit is to learn how well different types of oil will burn in various types of oil burner.

• **FORECASTS.**—A paper on Oil for the Homes of America was prepared by H. M. Hancock, superintendent, inspection department, The Atlantic Refining Co., in collaboration with E. T. Knight and Dr. A. B. Hersberger of the same company. It was presented by Dr. Hersberger.

The authors pointed out that the population in the United States will increase at an annual rate of 1%. Dwelling units are estimated to increase at a rate of 1.9% annually. Oil burners used for the heating of homes will increase at an average annual rate of 8.8%. While projected forecasts for 1955 are on a national basis, it is expected that the large increase in the use of oil burners will occur in the east and mid-west.

Home heating oils of the future will have a higher content of catalytically cracked distillate and will have a lower burning index than those now being marketed. Manufacturers should design burners to operate more effectively with oil of lower burning index.

• **HEAT TRANSFER.**—Professor W. J. King, director



Three 30 horsepower Century SCH motors driving refrigeration compressors in a packing-locker-ice plant.

Start Refrigeration Compressors Easily • Smoothly Quietly • *Without Over-motoring*

Refrigeration compressors under load are easily handled by Century SCH motors with high starting torque and low starting current. With this type Century motor it isn't necessary to over-motor the running load in order to get enough starting torque to start the compressor.

This often means that a motor with the next lower horsepower rating can be used when you select a Century SCH motor instead of a general purpose squirrel cage motor.

Century motors are built with rugged frames and accurately machined feet to assure solid mounting. They are well balanced mechanically and electrically. All these features and many others contribute to the smooth, quiet, dependable operation of Century motors.

There is a Century motor for every refrigeration, air conditioning and air circulating application. They are built in a wide range of types, in sizes from 1/6 to 400 horsepower. They are all engineered to the requirements of the machines they drive to assure top performance.

Specify Century for all your electric power requirements.

Century C MOTORS

506

of the Sibley School of Mechanical Engineering, Cornell University, spoke on the Heat Transfer Knowledge Gained from Jet Type Engines.

He said that the heat transfer rate for domestic oil burners is 50,000-150,000 Btu per hr per cu ft. For large industrial burners using pulverized coal this is 20,000 Btu per hr per cu ft and for German jet type engines this is 11,000,000 Btu per hr per cu ft.

Professor King cited Jet-Heet (H&V:2:47:p99) as an example of the jet heat engine applied to domestic heating. With this warm air furnace, the makers claim the overall thermal efficiency is 93-95%, and exhaust gases are cooled to 140F. Trouble that might develop from condensation due to low exhaust gas temperatures are avoided by the high velocity of air in the exhaust line.

Beside the Engineering Session, there was a special merchandising meeting and a gathering termed the Industry Forum.

About 600 registered for the convention. The 1948 convention will be held the week of April 5 at the Coliseum, Chicago, in connection with an industry show.

COOLED TROLLEY COACHES

delivered for Atlanta in-city service use air conditioning capacity of railway coaches.

Residents of Atlanta, Ga., will be the first in the nation to ride comfortably in summer's heat in air conditioned trolley coaches — 30 of which have been delivered.

This is a new development in air conditioning engineering, (H&V:11:45:p88) since the coaches stop every block or so, permitting the heated outside air to stream in through the open doors. Heretofore, bus air conditioning has been confined to inter-city buses which roll for many miles between stops, thus lessening the load on the air conditioning system.

To maintain cool comfort in the Atlanta trolley coaches, despite frequent door-openings, Carrier equipment which has a cooling and dehumidifying capacity equal to that used on railroad coaches, and twice that required by inter-city buses, has been installed.

• **SYSTEM.**—The system consists of two Carrier air conditioning units and one Carrier Freon compressor. The compressor is driven by a 600-volt d-c motor, receiving current from the trolley system. Two separate air-cooled condensers are used, each provided with fan and motor. Cooling capacity control is automatic. The driver can use the fans of the air conditioning units to provide ventilation with the use of the refrigerating equipment, if he so chooses.

Mounted over the roof of the coach, the air conditioning units are held by steel framing which carries the load to the side walls, or posts. Cork pads isolate the unit from the frame, and there is no direct contact with the roof at any one point.

The compressor-motor assembly is mounted on a rigid structural steel frame, welded, and attached to the coach underframing members through vibration eliminators. The assembly is protected from splash by a sheet metal housing which covers the bottom and sides. Air is forced through this enclosure, entering a louvered opening at the motor end and escaping along the sides and at the compressor end. This air flow is set up by the forward motion of the coach.

Ducts passing down both sides of the coach at the ceiling distribute the air through perforations at the rate of 800 cfm, while the fans circulate a total of 2,200 cfm through the coach.

• **POWER.**—Electric motor requirements for the complete installation include a 10-hp on the refrigeration compressor, two one-hp fans for pulling the air through the refrigeration condensing coils, and two one-half-hp fans for circulating the air through the cooling and dehumidifying coils and filters and for drawing in the outside air.

The Atlanta trolley coach system is operated by the Georgia Power Company.

CONVECTOR PRODUCTION

rises sharply as CMA examines standards and ratings.

The production achievements of the manufacturers of convectors, standardization of sizes of convectors, and the new testing and rating code for convectors were among the subjects discussed at the annual meetting of the Convector Manufacturers Association at the Hotel Cleveland, Cleveland, Ohio, January 31, held in connection with the exposition and convention of the ASHVE.

• **OFFICERS.**—L. D. Mandell, assistant to the president, C. A. Dunham Company, Chicago, was elected president of the association. Mr. Mandell succeeds W. R. McMahon, assistant sales manager, Modine Manufacturing Company, Racine, Wis.

E. A. Cline, manager of convector sales, The Trane Company, La Crosse, Wis., was elected secretary-treasurer of the association. Mr. Cline succeeds D. F. Bennett of Warren Webster & Company.

• **PRODUCTION.**—"The current rate of production of the convector industry is more than twice our pre-war rate," said Mr. McMahon in his report as retiring president. "During the year 1946 there were 17.3 million square feet of convectors produced, according to a report of the Civilian Production Administration. Production of convectors during the fourth quarter of 1946 amounted to 6.9 million square feet."

Significant new developments in convectors such as the baseboard convector and the radiant convector were discussed at the meeting.

The new testing and rating code for convectors drawn up under the joint sponsorship of the Convector Manufacturers Association and The Institute of Boiler and Radiator Manufacturers with the assistance of the National Bureau of Standards was reviewed.

Considerable progress is being made by manufacturers in the standardization of convector sizes. Further activity in this direction is contemplated.

Conversion OF HEATING SYSTEMS

means profitable ductwork business

When home owners or building operators decide to change over from one type of heat to another, there may be changes involved in the existing ductwork. Ductwork replacements may be needed, or entirely different duct arrangements may be required. In either event a switch-over in heating systems can mean additional business and profits for the sheet-metal contractor.

When considering this profitable business don't forget the importance of using easy-to-work, rust-resisting steel sheets.

Beth-Cu-Loy Galvanized Steel Sheets are well suited for any kind of heating system where ductwork is used. They are ductile and easy to form. They make clean, fast work of difficult jobs. They have high resistance to corrosion, due to their coating of Prime Western zinc and their base of copper-bearing steel.

Beth-Cu-Loy Galvanized Sheets cost little more than ordinary galvanized sheets. This slight difference is far outweighed by Beth-Cu-Loy's longer life.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

Beth-Cu-Loy Galvanized Sheets

BETHLEHEM STEEL

Abstracts AND Reviews

Publications abstracted in this department should be ordered direct from publisher.

ASHVE GUIDE

The twenty-fifth edition of the Heating, Ventilating and Air Conditioning Guide has just been published. There are three parts to the volume; the technical data section, the manufacturers' catalog data section, and a list of members of the society.

The technical section is divided into 51 chapters grouped in eight sections as follows: Principles; human reaction to atmospheric environment; heating and cooling loads; combustion and consumption of fuels; heating systems and equipment; air conditioning; special applications; installations and testing codes.

Several of the chapters of the previous edition have been expanded, and much of the information in the previous edition has been revised. A large Mollier diagram for moist air is enclosed with the book.

Heating, Ventilating and Air Conditioning Guide. Cloth bound, 6 x 9 in., 1410 pages. Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York. Price, $6.

HYDRAULIC MEASUREMENTS

The second edition of Hydraulic Measurements by Herbert Addison, Professor of Hydraulics at the Fuad I University, Giza, Egypt, has just been published.

Some of the chapters included in this edition cover data on the measurement of weight and volume; velocity; discharge by free-flow apparatus; discharge in closed pipes; discharge in closed pipes and conduits; discharge in open streams. Various measuring instruments are described.

Hydraulic Measurements, by Herbert Addison. Cloth bound, 5½ x 8½ in., 327 pages. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York. Price, $5.

HOT WATER HEATING

There are few engineers if any in this country who have spent as many years in research on hot water heating as Dr. F. E. Giesecke, formerly Director of the Engineering Experiment Station at Texas A & M, and prior to that head of engineering research at University of Texas. Over twenty years ago Dr. Giesecke was the author of a series of articles in HEATING AND VENTILATING on gravity hot water heating, and this was followed by a book on the same subject.

More recently (1940), Dr. Giesecke was the author of six articles on radiant heating, a subject closely allied to hot water heating since most U. S. radiant heating installations have employed water as the heating medium.

The experience he gained over a period of fifty years in hot water heating and related subjects has now been incorporated into a 260-page book entitled "Hot Water Heating and Radiant Heating and Radiant Cooling." These three subjects are given 166, 66 and 28 pages respectively.

In addition to introductory chapters on fundamentals, heat requirements of buildings, and radiators and convectors, there are 16 chapters each relating to the design of a specific type of hot water system, including: elementary forced, elementary gravity, one pipe forced, one pipe gravity, two pipe reverse return gravity, two pipe reverse return forced, two pipe direct return forced, two pipe direct return gravity, forced for four story building, gravity for four story building, small radiant heating, etc.

In the section on radiant heating are chapters on panel surface temperature, design of warm water panel, and design of warm air panel.

Tables, graphs and formulas necessary for the solution of problems are included throughout; the text is simple to follow and the drawings are clear and sharp.

Hot Water Heating and Radiant Heating and Radiant Cooling by F. E. Giesecke, consulting engineer, New Braunfels, Texas. Bound in cloth, 6¼ x 9¼ in., 260 pages, price $4. Published by The Technical Book Co., P. O. Box 62, Austin, Tex.

● ● ●

EFFICIENT USE OF PORTABLE FANS—As the result of a cooperative project between Westinghouse Electric Corp., and the Agricultural and Mechanical College of Texas, Bulletin No. 95 has been issued. Tests were conducted under actual living conditions in various homes in order to make the data as practical as possible. Tests were conducted in single houses in Houston, Dallas, and College Station, Tex., and in an apartment in Dallas. Results in temperature reduction are given for various bedroom locations, living and other rooms. The author discusses methods of increasing comfort in kitchens, bathrooms and powder rooms. An appendix and bibliography are added that may prove of value to other experimenters. Report consists of 89 pages and may be obtained by writing to the Texas Engineering Experiment Station, A & M College of Texas, College Station, Tex.

MEASUREMENT OF SOLAR ENERGY—Extensive treatment of this subject is given in Pyrheliometers and Pyrheliometeric Measurements by I. F. Hand of the U. S. Weather Bureau. He describes the types of measurements and instruments and then gives a few illustrative problems for the calculation of typical conditions. The paper includes tabulations of solar altitudes for various latitudes and for various times of the year. The paper contains tabular material of special interest to those engaged in a study of radiation from the sun. Copies available from the U. S. Department of Commerce, Washington 25, D. C.

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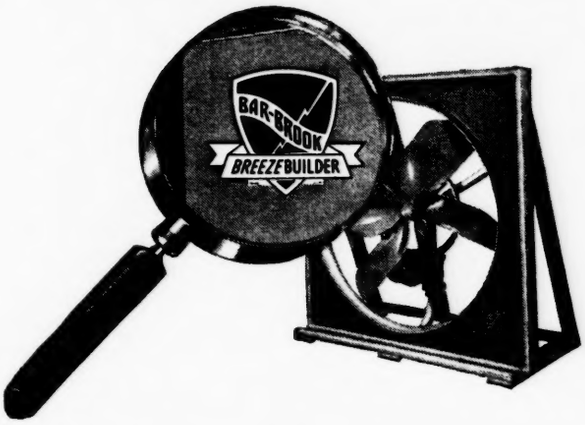

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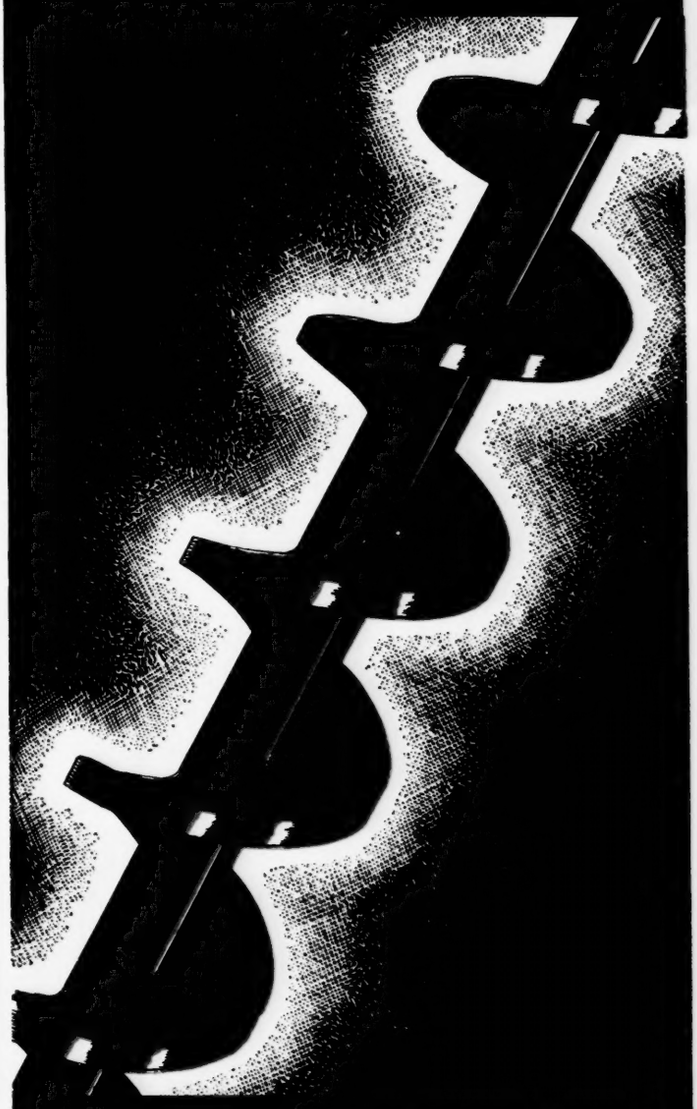
All PITCHES AND SIZES



is an extremely versatile material. Not only is it tough and wear resisting, but it is capable of being readily shaped into an infinite variety of sizes and pitches, tapered or constant diameter, right hand or left hand. That's why so many stoker manufacturers use the Crown wrought steel stoker feed screw. They know that Crown can produce a tough, continuously welded wrought steel screw to meet their most exacting specifications.

Send specifications and drawings for price.

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Degree-Days for February, 1947

HEATING AND VENTILATING's 20th Year of Publication of Monthly Degree-Day Data

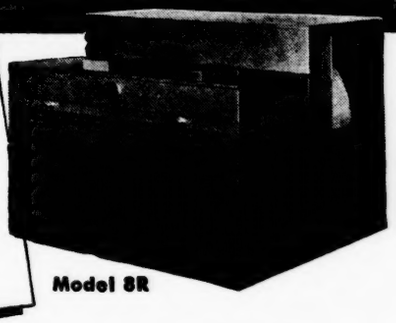
City	February			Cumulative, Sept. 1, 1946 to Feb. 28, 1947			Heating Season[1]
	1947	1946	Normal	1946-47	1945-46	Normal	Normal
Abilene, Texas	637	381	510	2194	2142	1761	2061
Albany, New York	1224	1206	1142	4677	5197	4868	6580
Albuquerque, New Mexico	637	697	692	3380	3509	3443	4298
Alpena, Michigan	(a)	1308	1278	(a)	5604	5660	8299*
Anaconda, Montana	1101	1041	1164	6016	5435	5656	8357**
Asheville, North Carolina	956	653	756	2950	3258	3276	4232
Atlanta, Georgia	739	491	557	2143	2471	2370	2890
Atlantic City, New Jersey	948	805	904	2958	3415	3631	5176
Augusta, Georgia	608	360	423	1658	1895	1864	2161
Baker, Oregon	807	1000	991	5093	5026	5024	7163
Baltimore, Maryland	928	751	843	2879	3276	3462	4533
Billings, Montana	1138	944	1120	5340	4899	5254	7119
Binghamton, New York	1191	1115	1182	4264	4823	4965	6808
Birmingham, Alabama	734	469	521	2090	2366	2023	2352
Bismarck, North Dakota	1495	1470	6869	6577	6994	6869	9192
Block Island, Rhode Island	965	957	983	3389	3894	3767	5788
Boise, Idaho	752	870	848	4540	4336	4230	5552
Boston, Massachusetts	992	1050	1042	3739	4339	4322	6045
Bozeman, Montana	1059	1082	1208	5701	5637	5897	8521**
Buffalo, New York	1216	1130	1156	4335	4895	4768	6822
Burlington, Vermont	1362	1374	1294	5219	5771	5496	7514
Butte, Montana	1154	1113	1143	6336	5896	5635	8272
Cairo, Illinois	916	577	762	2813	3056	3169	3909
Canton, New York	1384	1473	1328	5436	6063	5842	8020
Charles City, Iowa	1401	1164	1273	5261	5807	5728	7588
Charleston, South Carolina	525	309	372	1241	1565	1491	1769
Charlotte, North Carolina	763	507	588	2239	2508	2533	3120
Chattanooga, Tennessee	826	567	602	2568	2802	2559	3118
Cheyenne, Wyoming	1152	981	1075	5183	5004	5179	7466
Chicago, Illinois	1192	981	1039	4114	4547	4401	6077
Cincinnati, Ohio	1030	738	862	3185	3673	3675	4684
Cleveland, Ohio	1186	956	1075	3998	4345	4441	6155
Columbia, Missouri	1029	693	897	3517	3827	3903	4922
Columbia, South Carolina	630	398	498	1705	2021	2000	2364
Columbus, Ohio	1144	862	980	3667	4071	4113	5398
Concord, New Hampshire	1197	1318	1240	5086	5661	5321	7353
Concordia, Kansas	1026	664	970	4013	3936	4173	5315
Dallas, Texas	590	345	493	1905	1917	1980	2256
Davenport, Iowa	1245	986	1140	4340	4846	4825	6289
Dayton, Ohio	1201	897	980	3944	4407	4043	5264
Denver, Colorado	962	764	918	4164	3979	4273	5874
Des Moines, Iowa	1289	939	1173	4590	4859	4935	6384
Detroit, Michigan	1192	1077	1134	4261	4709	4718	6490
Devils Lake, North Dakota	1632	1698	1551	7219	7862	7371	9970
Dodge City, Kansas	932	654	890	3832	3663	3958	5035
Dubuque, Iowa	1310	1077	1218	4744	5222	5194	6790
Duluth, Minnesota	1508	1536	1464	6618	6981	6680	9483
Eastport, Maine	1102	1279	1232	4971	5502	5502	8520**
Elkins, West Virginia	1221	881	991	4017	4265	4256	5697
El Paso, Texas	428	462	434	2252	2233	2101	2428
Ely, Nevada	846	1097	(a)	5435	5529	(a)	(a)
Erie, Pennsylvania	1163	1026	1098	3877	4348	4434	6273
Escanaba, Michigan	1330	1325	1340	5656	5941	6028	8771*
Evansville, Indiana	1044	725	854	3351	3669	3348	4244
Fort Smith, Arkansas	795	494	630	2540	2695	2657	3147
Fort Wayne, Indiana	1241	1022	1098	4355	4840	4503	5925
Fort Worth, Texas	592	349	498	1931	1934	1904	2148
Fresno, California	353	440	389	2270	2005	1883	2334
Galveston, Texas	394	225	255	1119	979	938	1016
Grand Junction, Colorado	815	880	863	4504	4470	4374	5548
Grand Rapids, Michigan	1193	1102	1204	4350	4859	4863	6535
Green Bay, Wisconsin	1355	1258	1358	5434	5858	5778	7825
Greensboro, North Carolina	876	620	678	2740	3090	2845	3529
Greenville, South Carolina	762	523	661	2279	2641	2739	3380
Harrisburg, Pennsylvania	1049	926	1008	3639	4069	4077	5375
Hartford, Connecticut	1077	1105	1100	4070	4758	4416	6036
Hatteras, North Carolina	655	484	535	1483	1933	1851	2571
Havre, Montana	1385	1146	1450	6379	5885	6388	8700
Helena, Montana	1058	968	1178	5914	5318	5611	7898
Houston, Texas	421	216	277	1189	1121	1092	1157
Huron, South Dakota	1387	1266	1340	5792	6171	6075	8004
Indianapolis, Indiana	1148	857	969	3648	4127	4099	5298
Jackson, Mississippi	630	367	(a)	1746	1884	(a)	(a)
Kansas City, Missouri	1007	651	946	3552	3743	3953	4956
Kewanee, Illinois	1228	988	1006	4339	4641	4640	6139
Knoxville, Tennessee	891	592	666	2713	2945	2964	3670
La Crosse, Wisconsin	1377	1260	1265	5479	5981	5578	7322
Lander, Wyoming	1129	1004	1155	5731	5642	5666	7947

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill.; Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, Box 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on Page 122]

BRYANT SILICA-GEL
AIR-DRYERS



Designed for efficient CO-ORDINATED OPERATION with all types of AIR CONDITIONING EQUIPMENT

Model 8R

• Provides a continuous flow of dry air offering accurate control of humidity in air conditioning systems for

PRODUCT FABRICATION

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AIR CONDITIONING ENGINEERS AND CONTRACTORS

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3 Special Features:

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Installations of these new-type radiator traps show that their faster action saves in heat-up time and steam. 2 types, for 200 and 400 sq. ft. EDR, vapor and vacuum; pressure to 25 lbs. Competitively priced.

Bulletin 744 describes new traps

W. H. NICHOLSON & CO. 199 OREGON STREET WILKES-BARRE, PA.

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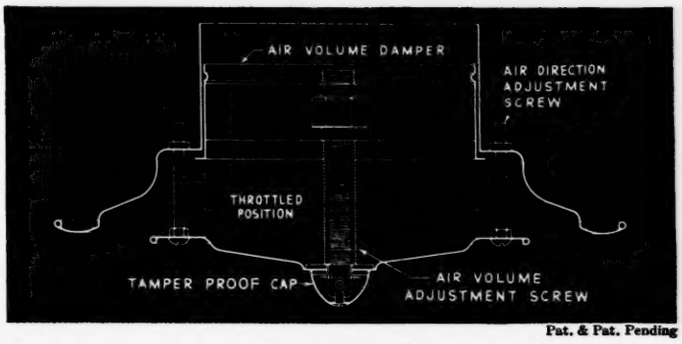
How ADJUSTABLE air diffusers increase the efficiency of supply air distribution

Kno-Draft Adjustable Diffusers offer all the advantages of draftless air diffusion plus fast system balancing and air pattern control



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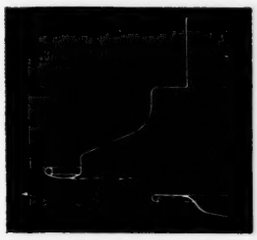
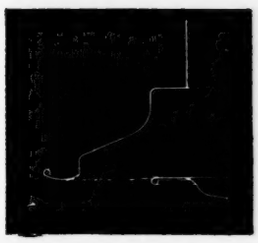
Fast System Balancing: Volume damper regulates the air outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

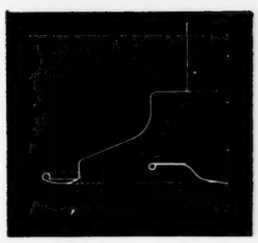
Positive Air Pattern Control: Air direction adjustment affords any angle of air discharge from vertical to horizontal needed to accommodate ceiling heights, individual or seasonal requirements. It can expel chilled air parallel to the ceiling or eject heated air downward to prevent stratification.



Specify Kno-Draft Adjustable Air Diffusers for better mixing control of room and supply air, more uniform temperatures throughout the occupied zone and noiseless, draftless air distribution.



Send for FREE handbook containing sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. For your copy, please write Dept. E-13 on company letterhead.



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Degree-Days for February, 1947 (Concluded)

HEATING AND VENTILATING's 20th Year of Publication of Monthly Degree-Day Data

City	February			Cumulative, Sept. 1, 1946 to Feb. 28, 1947			Heating Season[1]
	1947	1946	Normal	1946-47	1945-46	Normal	Normal
Lansing, Michigan	1239	1147	1201	4630	5163	5202	7048
Lewiston, Maine	1127	1319	1243	5217	5843	5532	7707
Lincoln, Nebraska	1129	785	1131	4282	4326	4643	5999
Little Rock, Arkansas	758	464	582	2361	2543	2380	2811
Livingston, Montana	1061	940	1067	5434	4930	5018	7205
Los Angeles, California	155	288	266	971	925	1016	1504
Louisville, Kentucky	1006	670	801	3081	3363	3327	4180
Lynchburg, Virginia	955	677	730	2981	3321	3143	3980
Macon, Georgia	602	374	462	1743	1953	1908	2201
Madison, Wisconsin	1344	1184	1299	5071	5580	5557	7429
Marquette, Michigan	1318	1340	1361	5609	5943	5915	8693*
Memphis, Tennessee	799	507	599	2389	2671	2470	2950
Meridian, Mississippi	632	381	456	1804	1915	1891	2160
Milwaukee, Wisconsin	1331	1121	1201	4946	5180	5185	7245
Minneapolis, Minnesota	1408	1352	1400	5722	6228	5950	7850
Modena, Utah	742	950	905	4662	4653	4764	6562
Montgomery, Alabama	572	327	392	1504	1779	1676	1884
Nantucket, Massachusetts	959	970	974	3577	3889	3912	5957
Nashville, Tennessee	917	587	675	2674	3012	2850	3507
New Haven, Connecticut	1074	1033	1011	3849	4428	4230	5895
New Orleans, Louisiana	392	195	230	967	1041	965	1024
New York, New York	1006	940	1028	3313	3799	3837	5274***
†Nome, Alaska	2302	1559	1990	7569	6946	8886	14580**
Norfolk, Virginia	782	560	650	2100	2505	2583	3350
North Head, Washington	519	613	622	3229	3169	3132	5452**
North Platte, Nebraska	1078	793	1020	4615	4405	4806	6366
Oakland, California	375	501	403	2226	2113	2029	3143**
Oklahoma City, Oklahoma	760	483	742	2730	2714	2896	3613
Omaha, Nebraska	1213	877	1126	4481	4670	4765	6131
Oswego, New York	1194	1186	1162	4429	4967	4933	7088
Parkersburg, West Virginia	1081	782	879	3307	3669	3701	4775
Peoria, Illinois	1219	957	1067	4297	4759	4673	6109
Philadelphia, Pennsylvania	978	829	881	3078	3553	3542	4737***
Phoenix, Arizona	142	303	263	1175	1348	1253	1405
Pittsburgh, Pennsylvania	1204	844	944	3768	3900	3947	5235
Pocatello, Idaho	846	1025	986	5037	5179	4853	6655
Portland, Maine	1129	1285	1162	4982	5604	5088	7218
Portland, Oregon	473	567	644	3025	2905	3174	4469
Providence, Rhode Island	982	1008	1070	3658	4204	4316	6015
Pueblo, Colorado	957	769	916	4366	4173	4140	5514
Raleigh, North Carolina	785	539	630	2256	2629	2605	3234
Rapid City, South Dakota	1245	909	1119	5385	4948	5140	7118
Reading, Pennsylvania	1018	908	980	3440	3924	4082	5389
Red Bluff, California	355	542	(a)	2158	2186	(a)	(a)
Reno, Nevada	645	852	823	4192	4092	4149	5892
Richmond, Virginia	862	624	695	2576	2997	2906	3695
Rochester, New York	1219	1164	1159	4412	5010	4825	6732
Roseburg, Oregon	489	581	605	3183	2831	3090	4428
Roswell, New Mexico	647	558	580	2772	2752	2876	3484
Sacramento, California	393	490	426	2247	2035	2036	2653
St. Joseph, Missouri	1062	695	974	3831	4047	4121	5161
St. Louis, Missouri	1020	682	854	3237	3594	3652	4585
Salt Lake City, Utah	745	856	885	4500	4421	4144	5555
San Antonio, Texas	461	269	274	1486	1389	1128	1202
San Diego, California	185	296	280	1050	983	1099	1645
Sandusky, Ohio	1157	961	1061	3892	4328	4384	6208
San Francisco, California	321	398	356	1899	1703	1770	3264**
Sault Ste. Marie, Michigan	1426	1479	1487	6027	6494	6315	9285**
Savannah, Georgia	506	279	316	1155	1440	1323	1490
Scranton, Pennsylvania	1157	1050	1106	4053	4518	4552	6129
Seattle, Washington	514	576	647	3242	2978	3297	4934**
Sheridan, Wyoming	1185	1048	1160	5498	5165	5789	8008
Shreveport, Louisiana	604	342	412	1796	1864	1796	1938
Sioux City, Iowa	1329	1032	1260	5217	5363	5278	6898
Spokane, Washington	812	832	952	4839	4540	4707	6355
Springfield, Illinois	1101	833	1008	3768	4132	4191	5373
Springfield, Missouri	1016	642	876	3414	3563	3523	4428
Syracuse, New York	1245	1171	1212	4530	5046	4980	6893
Tacoma, Washington	541	603	675	3487	3265	3438	5181**
Terre Haute, Indiana	1141	814	966	3615	4016	3876	4872
Toledo, Ohio	1204	1016	1075	4276	4725	4467	6077
Topeka, Kansas	1013	621	935	3663	3713	3953	4969
Trenton, New Jersey	1017	898	941	3345	3837	3715	4933
Utica, New York	1253	1132	1181	4067	5220	4966	6796
Valentine, Nebraska	1205	932	1130	5202	4972	5225	7039
Walla Walla, Washington	650	625	778	3773	3384	3676	4808
Washington, D. C.	933	716	848	2891	3309	3559	4626
Wichita, Kansas	931	587	896	3474	3464	3773	4673
Williston, North Dakota	1536	1434	1495	6722	7014	6958	9323
Winnemucca, Nevada	675	883	905	4523	4426	4644	6427**
Yakima, Washington	719	742	846	4506	3970	4433	5599

(a) Data not available.
†Nome data are for January.

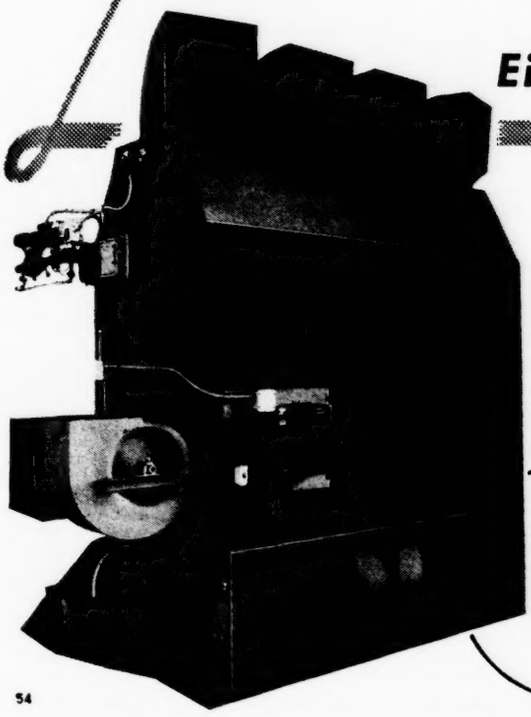
*Includes August.
**Includes July and August.
***New 48-year normal covering 1898 to 1946.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

AIRTHERM

DIRECT-FIRED WARM AIR HEATERS

Now Available
Either Gas or Oil Fired



Capacities from 650,000 to 1,950,000 B.T.U.

The Airtherm self-contained heater provides heat only where you want it — when you want it. It is not necessary to maintain fire during off-heating periods. The Airtherm Heater is always ready to provide heat at the command of the thermostat.

Write for Bulletin 801 describing this economical heater in detail.

AIRTHERM MANUFACTURING COMPANY

54 **722 South Spring Avenue** **St. Louis**

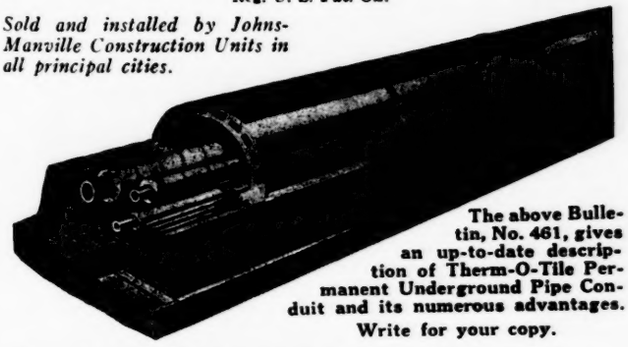
Have You Asked for Your Copy?

When you install Therm-O-Tile Underground Pipe Conduit you get much more for your money. Insulation is always dry. Efficiency is permanently high. The "Spread Footing" foundation maintains grades permanently. Stronger. First cost is competitive. Lowest final cost. Etc.

THERM-O-TILE

Reg. U. S. Pat. Off.

Sold and installed by Johns-Manville Construction Units in all principal cities.



The above Bulletin, No. 461, gives an up-to-date description of Therm-O-Tile Permanent Underground Pipe Conduit and its numerous advantages. Write for your copy.

H. W. PORTER & CO., Inc.

823-V Frelinghuysen Ave. **Newark 5, N. J.**

AIR RECTIFIERS, Inc.
3734 Southport Ave.
CHICAGO 13, ILL.

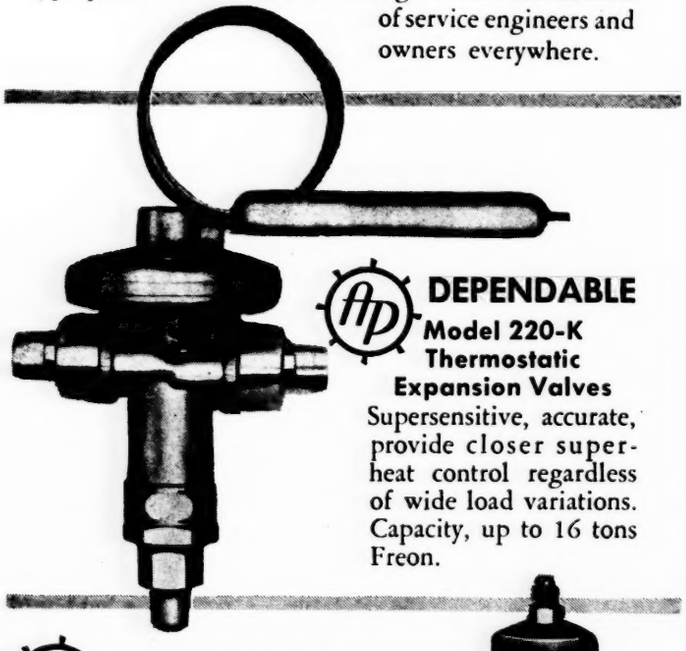
DIV. 15

This valuable catalog contains a full line of the NEW IMPROVED INDIVIDUAL GLASS BLOCK VENTILATORS and various adaptations for their use in new building and remodeling. It also offers a comprehensive line of air filters and ventilators for walls, roofs and all types of formal construction.

DEPENDABLE
Refrigerant Valves

Help Reduce Service Attention on *ANY* Air Conditioning System

Good "service insurance" on any system, new or old, A-P DEPENDABLE Refrigerant Valves help you maintain peak efficiency with minimum service attention. Their operation on thousands of air conditioning jobs of every type prove this valuable advantage — for the benefit of service engineers and owners everywhere.



DEPENDABLE
Model 220-K Thermostatic Expansion Valves
Supersensitive, accurate, provide closer superheat control regardless of wide load variations. Capacity, up to 16 tons Freon.

DEPENDABLE
Water Regulating Valve Model 68-B
Maintains ideal, economical water-flow, condensing-pressure relationship. Adjustable. Operating head pressure range, 50 to 150 p.s.i. Has exclusive self cleaning feature that stops "dirt-and-lime" troubles.

WRITE for complete details on all A-P DEPENDABLE Refrigeration Valves:

Thermostatic Expansion Valves, Refrigerant and Water Solenoids, Water Regulating Valves, Suction Pressure Regulating Valves, "Trap-It" and "Trap-Dri" System Protectors and Cooling Thermostats.

AUTOMATIC PRODUCTS COMPANY
2462 North Thirty-Second Street, Milwaukee 10, Wisconsin
Export Dept., 13 East 40th Street, New York 16, New York

DEPENDABLE
Refrigerant Valves
AIR CONDITIONING • REFRIGERATION • HEATING

NEW CATALOGS

Warm Air Heater

Bulletin No. 516, 12-pages, illustrated, describes the new Dravo Counterflo heater for industrial and commercial use. The bulletin shows the application of stainless steel to combustion chambers in this self-contained, direct-fired, warm air heating unit which is convertible to either oil or gas.—*Dravo Corp., 300 Penn Ave., Pittsburgh 22, Pa.* 229

Pyrometer

The Alnor line of pyrometers and thermocouples is covered by two new bulletins, Nos. 4257 and 4361. Bulletins include diagrams, photographs and price lists. —*Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.* 230

Engineering Service

Bulletin 303, 8 pages in two colors, offers manufacturers of original blower equipment a complete engineering service for the building of blower assemblies in their own plants.—*Morrison Products, Inc., E. 168 & Waterloo Rd., Cleveland 10, Ohio.* 231

Color Dynamics

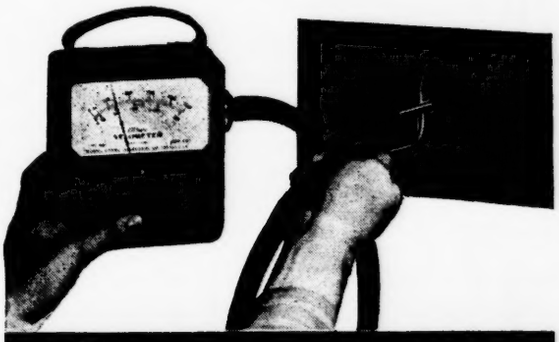
How scientific use of color in plants and factories increases over-all efficiency is shown graphically in a new full-color, 32-page booklet. Sections are devoted to the use of color on machinery and equipment; on walls and ceilings; and on floors, aisles, and mobile equipment with emphasis on color for safety. A special section contains simplified and practical material specifications for industrial painting.—*Dept. NIB Public Relations Department, Pittsburgh Plate Glass Co., 632 Duquesne Way, Pittsburgh 22, Pa.* 232

Tube Fittings, Valves, Tools

Over 1100 sizes, types and styles of tube fittings, hose fittings, brass pipe fittings and shut-off valves are listed and described in catalog No. 350. The catalog also describes tubing cutters, flaring tools, tube benders, swedging tools, air nozzles, machinery cleaner, barrel faucet, welding, cutting and soldering equipment, fuel strainers and dash controls. A fitting selector chart is provided.—*The Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago 7, Ill.* 233

Dust Precipitator

A new, 19-page, illustrated booklet covers the type D Roto-Clone dynamic precipitator, a device designed for the dry collection of practically every type of granular industrial dust. The booklet shows detailed views together with capacity and dimension tables for each size.—*American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Kentucky.* 234



Alnor VELOMETER

the direct reading air velocity meter

Air speed in feet per minute is read directly and instantly on the scale of the Alnor Velometer. Anyone can use this simple instrument—there are no calculations, no leveling, no timing, and no conversion tables. This convenient instrument allows quick checking of draft, leaks, velocities at air conditioning outlets, and any other air movement. Quick, accurate air velocity measurements give a valuable check on efficiency of equipment.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm, and up to 3 inches total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for bulletin with complete data.

ILLINOIS TESTING LABORATORIES, INC.
420 NORTH LA SALLE STREET
CHICAGO 10. ILLINOIS

Phillips Float Controls

Another Phillips Product

. . . PILOT OPERATED LIQUID CONTROL VALVE

May be piloted by either float, thermal or electric valve.

The recognized higher efficiency rate of a flooded operated evaporator in a refrigerating or air conditioning system is further emphasized when the evaporator is used in conjunction with Phillips Float Controls. Maximum B. T. U. transfer is assured. These controls respond so instantly to any wide variations in load that their use is indicated on practically all installations. Available capacities: "Freon," 20 to 500 tons; Ammonia, 1 to 2000 tons. For high or low side applications. Write for NEW Bulletin.

The Home of Phillips Regulating Valves and Float Controls
Established in 1929

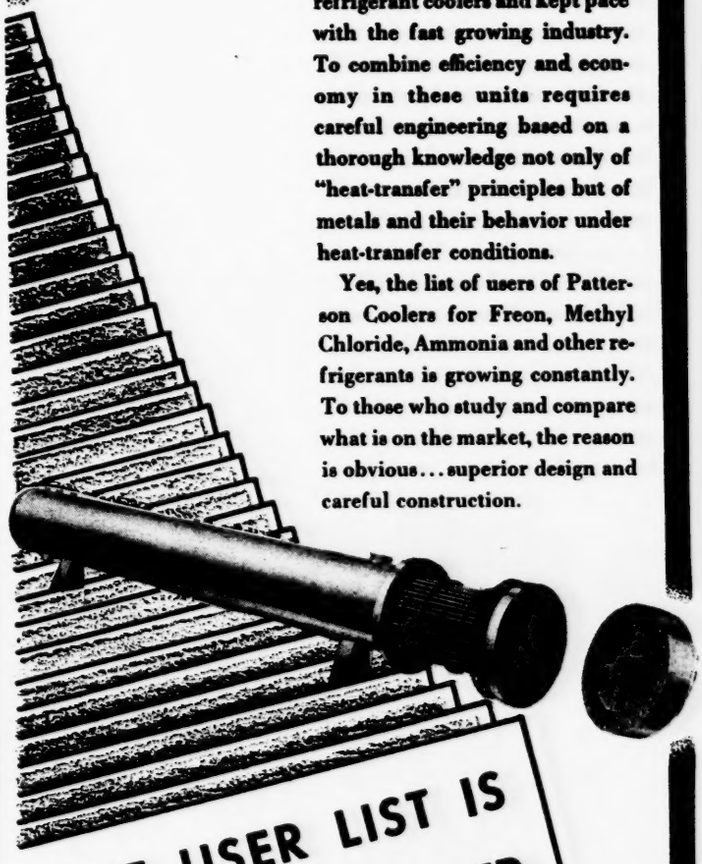
H. A. PHILLIPS & COMPANY
3255 W. CARROLL AVE., CHICAGO, ILLINOIS

Coolers

. . . by PATTERSON-KELLEY

Being "heat-transfer" specialists, it is only natural that long ago our engineers began to work on refrigerant coolers and kept pace with the fast growing industry. To combine efficiency and economy in these units requires careful engineering based on a thorough knowledge not only of "heat-transfer" principles but of metals and their behavior under heat-transfer conditions.

Yes, the list of users of Patterson Coolers for Freon, Methyl Chloride, Ammonia and other refrigerants is growing constantly. To those who study and compare what is on the market, the reason is obvious . . . superior design and careful construction.



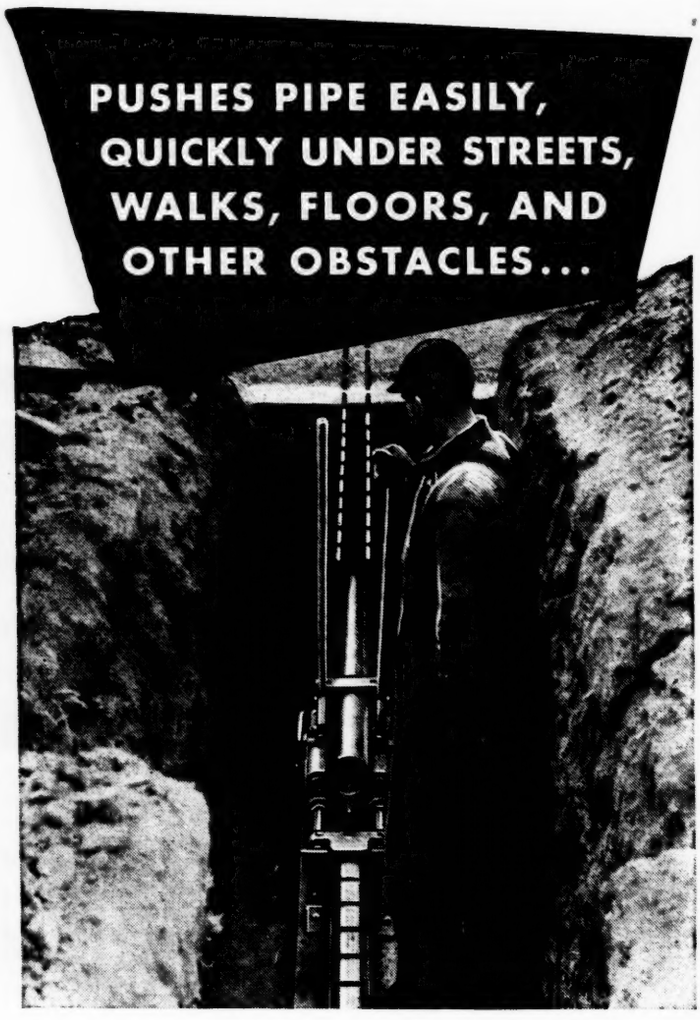
THE USER LIST IS GROWING LONGER . . . RAPIDLY

Write for new bulletin which describes the latest type of Patterson Dry Expansion Type Cooler illustrated above. You will be interested, for example, in the refrigerant chamber which is machined from a solid billet of rolled carbon steel with welded-in partitions.

THE PATTERSON-KELLEY Company, Inc.
122 WARREN STREET, EAST STROUDSBURG, PA.

NEW YORK 17—101 Park Ave. PHILADELPHIA 3—1700 Walnut St.
CHICAGO 4—Railway Exch. Bldg. BOSTON 16—96-A Huntington Ave.

Representatives in Principal Cities



GREENLEE HYDRAULIC PIPE PUSHER

Here's how you can cut costs, save time on underground pipe installations. With a GREENLEE Hydraulic Pipe Pusher *one man* can push pipe through the ground *easily, quickly* — under obstructions!

Save the time, work and inconvenience to all caused by the old methods of tearing up floors, lawns and pavement. Eliminate tedious back-filling, tamping, tunneling, re-paving (just a short trench accommodates the pusher).

Save with the GREENLEE which often pays for itself on the first few jobs used. Learn all about this compact, portable, powerful pipe installing equipment . . . get free Folder S-117. Greenlee Tool Co., Division of Greenlee Bros. & Co. 2324 Twelfth St., Rockford, Illinois, U.S.A.

REGISTERED TOOLS
GREENLEE
FOR THE CRAFTSMAN

Accessories

A 32-page bulletin entitled "Prospecting for Perfection," deals with the company's research and engineering background in the production of tube fittings, flexible hose, packless valves, and various other fluid handling accessories.—*The Weatherhead Co., 300 East 131st St., Cleveland 8, Ohio.* 235

Single Stage Process Pump

A 16-page illustrated bulletin, No. 46-7050, describes the BJ type SM single stage process pump, a centrifugal pump designed to handle either cold or hot fluids under conditions beyond the limitations of other types of pumps. Installation and construction photographs are supplemented by drawings and sizing tables.—*Byron Jackson Co., Box 2017, Terminal Annex, Los Angeles 54, Calif.* 236

Ball Bearings

A 20-page, 3-color bulletin, A-120, gives ball bearing engineering information covering pillow blocks, hanger bearings, flanged units, take-up units, cylindrical units as well as steel frame ball bearing take-ups. Selection tables provide a convenient means of selecting the right bearing for any application within the size and load range of the line.—*Dodge Mfg. Corp., Mishawaka, Indiana.* 237

Plumbing, Heating, Air Conditioning

Large, heavily bound, loose leaf general catalog, first issued in 1925 and revised periodically, has been reissued with full color index sheets, and covers the full line of American Radiator and Standard Sanitary Corporation. The catalog is in three main sections, plumbing, radiator heating, and warm air winter air conditioning. Binding of the catalog is designed for permanence, and data will be kept up to date by periodical revisions and the issue of new pages. Construction and sizing data on a full line of plumbing fixtures, hot water heaters, boilers, radiators, convectors, furnaces, blowers, controls and accessories are presented.—*American Radiator and Standard Sanitary Corporation, Pittsburgh 30, Pa.* 238

Die-Less Duplicating

Catalog No. 46-11, 40-pages, describes and illustrates the Di-Acro system of die-less duplicating, said to be an original process for duplication of small metal parts to die accuracy using Di-Acro machines as die substitutes.—*O'Neil-Irwin Manufacturing Co., Lake City, Minnesota.* 239

Insulation

Armstrong mineral wool board is the subject of an 8-page illustrated bulletin which describes the application of this material as low temperature insulation.—*Armstrong Cork Co., Lancaster, Pa.* 240

DRILLS ALL THE HOLES AT ONE PASS

Zagar Gearless Drillheads solve your multiple drilling problems. Created and developed by Zagar tool engineers. These drillheads enable your plant to produce a better, more uniform product with astounding savings in time and cost.

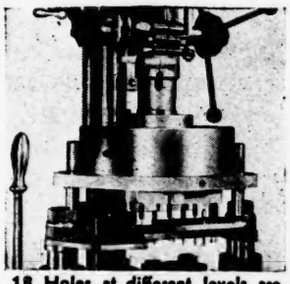
Any number of drills, in any pattern, located as close as twice the diameter of the drill, run at full power . . . noiselessly and vibration-free . . . on precision needle, tapered roller and ball bearings.

Standardized Zagar Gearless Drillheads are easily adaptable to your drill presses or can be obtained from us as a complete hydraulic machine.

WRITE FOR CATALOG NO. 18-4

ZAGAR TOOL, INC.

23880 Lakeland Blvd. Cleveland 17, Ohio



18 Holes at different levels are simultaneously drilled by this standard Zagar Drillhead adapted to a 17" Delta drill press.

Zagar

PRODUCTION TOOLING FOR INDUSTRY

DWYER PORTABLE DRAFT GAGE

simplifies precision measurements

Even inexperienced operators accurately measure pressure, vacuums and differentials with the new Dwyer Portable Draft Gage. Only a few moments instruction are required.

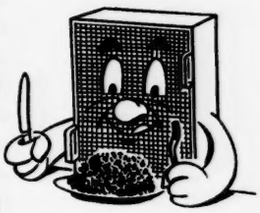
With the Dwyer gage, draft indication is continuous. All fluctuations can be seen while adjustments are being made. Strongly built of clear plastic, with indicating tube and oil chambers precision reamed and bored, the Dwyer Transparent Gage is built for long dependable service under any conditions. For detailed information write for illustrated literature.

F. W. Dwyer Mfg. Co.

309 South Western Avenue, Chicago 12, Illinois

As advertised in TIME and NEWSWEEK

The filter with a husky appetite . . . for dirt



A STEEL MILL is the toughest test of all for an air filter. In and around a mill the air is constantly laden with abrasive grit and dirt. Yet this same air must be used to supply engines and compressors, to cool motors and generators.

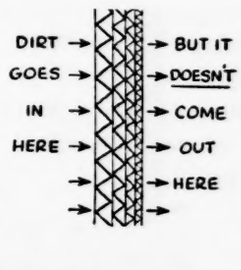
To make steel mill air fit for use takes a filter with a husky appetite for dirt. That's why so many plants specify *Air-Maze.*

ONE BIG PLANT near Pittsburgh uses over 400 Air-Maze filter panels to make certain that no harmful dirt reaches the insides of its mill motors. Each panel, only 20" square by 4" thick, collects more than 4 lbs. of grit and dust before it has to be cleaned.

Maintenance men everywhere prefer Air-Maze filters because they stop and hold practically all nuisance dirt with negligible effect on air delivery. Filters are all-metal, cleanable, last almost indefinitely.

YOU MAY NOT have to deal with "steel mill air." But if you use air for any purpose, Air-Maze engineers can help you whittle down the high cost of dirt. Wherever air moves, dirt rides along — grinds away at machine parts, impairs efficiency, increases maintenance cost. Everyday Air-Maze protects ventilating systems, gear cases, blowers, instruments and many other types of industrial equipment from the damaging effects of airborne dirt.

HAVE YOU A FILTERING PROBLEM? Whether you build or use engines, compressors, hydraulic equipment, lubricating systems, *or any device using air or liquids* — the chances are there is an Air-Maze *engineered* filter to serve you better. Write Air-Maze Corporation, Cleveland 5, Ohio.



AIR-MAZE

The Filter Engineers

These nationally advertised rugged, oversized units are built to give service under the most trying conditions. Available in 3, 5, 7 ton sizes.

When the water supply is less than normal, the oversized condenser will still keep head pressures within bounds and the machine will keep plugging along, turning in a beautiful job of air conditioning.

The big cooling coil and every other oversized part gives assurance that this TYPHOON unit, year after year, will deliver 12,000 BTU's of actual air conditioning performance for every ton of rating. This means a maximum of satisfaction for your customers and the very minimum of service headaches for you.

Write for further information and inquire if your dealer territory is still open.

Dept. 214

TYPHOON AIR CONDITIONING CO., INC.

Division of ICE AIR CONDITIONING CO., INC.

794 Union Street • Brooklyn 15, N. Y.

Temperature Regulators and Controllers

Bulletin No. 464—a new 24-page booklet: "Engineering, Operating and Maintenance Data on Temperature Regulators and Controllers" gives construction details of each class or type of regulator or controller in large cross-sectional color illustrations that highlight exclusive features. Both self-contained regulators and external-pilot-operated controllers are features. Included also are sizing and capacity tables to guide the selection of the proper regulator or controller for specific applications. Instructions for installing, operating, dismantling, cleaning and assembling are presented in an easily followed sequence.—*Leslie Co., 52 Delafield Avenue, Lyndhurst, N. J.* 241

Rivnut Data Book

A new edition of the 40-page Rivnut Data Book describes construction of regular and special Rivnut types; lists sizes, dimensions and grip range identifications; details installation methods and tools. The makers say the Rivnut is the only one-piece blind fastener which serves as both blind rivet and nut plate. —*B. F. Goodrich Co., Akron, Ohio.* 242

Tube Cutter

A 4-page folder, Bulletin No. A44, describes the Parker hand operated tube cutting tool and includes reference to other tube fabricating equipment. — *The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.* 243

Induction Motors

Totally enclosed, fan cooled, series C, type 3A, Reliance induction motors are described in bulletin C-118 which covers construction details of motors with high pressure ratings from ½ to 20 hp and 600 to 3600 rpm. —*The Reliance Electric & Engineering Co., 1076 Ivanhoe Road, Cleveland, Ohio.* 244

Condensate Return Units

A series of bulletins describes Eagan condensate return units including pumps, receivers, gauges, motors, etc., for use in steam systems where gravity return is impracticable.—*Walter H. Eagan Co., 2336-38 Fairmount Ave., Philadelphia, Pa.* 245

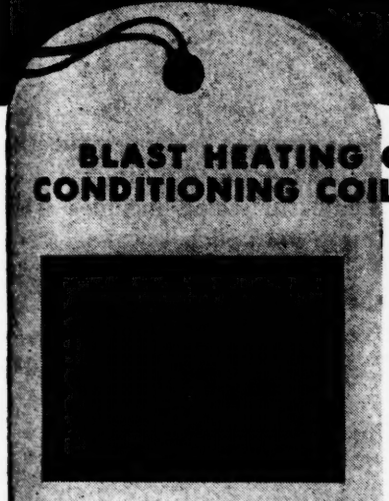
Feedwater Control Data

Bulletin 105-B, 16-pages, three colors, analyzes feedwater control problems and offers valves and instruments for maintaining and recording boiler water levels.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.* 246

Multi-Stage Pumps

Catalog B-1146 covers a line of vertically split case, multi-stage pumps built for larger capacities ranging from 50 to 200 gpm. Photographs, diagrams and performance charts are included.—*Economy Pumps, Inc., Hamilton, Ohio.* 247

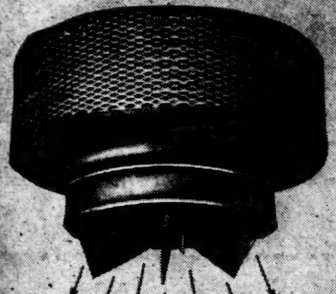
McCORD
HEATING AND AIR CONDITIONING PRODUCTS



BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

VERTICAL TYPE UNIT HEATERS



A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

HORIZONTAL TYPE UNIT HEATERS

A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.

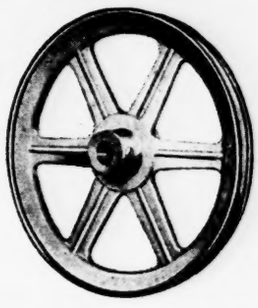
---

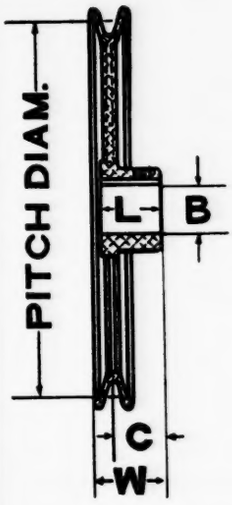
for SMOOTH, EFFICIENT OPERATION.... *use* CENTRAL STANDARDIZED DRIVES

"CENTRAL" Variable Pitch Pulleys

Silent and true running, diamond bored to plus or minus .0005"—CENTRAL Variable Pitch Pulleys are available to meet all conditions for fractional horsepower drives on HEATING, VENTILATING, AIR CONDITIONING and similar equipment. Speed variations of approximately 30% may be obtained by including a Variable Pitch Pulley in the drive—variations of about 500% by using both pulleys of this type and by interchanging them on the motor and driven shafts. Grooves accurately built to the belt, assuring perfect grip. For following V-Belts: 0—3/8", A—1/2" and B—5/8". Dimensions: Bore diameter, 1/2" to 1". Width of belt groove, min. 1/2", max. 7/8". Overall length of pulley, 1 5/8".

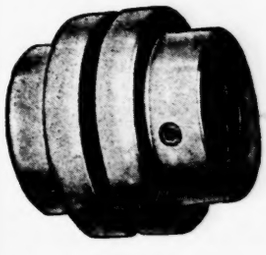
"CENTRAL" V-Grooved Pulleys





For Fans, Blowers, Stokers, Air Conditioners, Pumps, Refrigerators, Oil Burners, Compressors. Dimensions: *For A—1/2" Belts:* Pitch Dia., 1 1/8" to 13 5/8". Bore Dia., 1/2" to 1 1/2". Bore Length, 1 5/32" to 1 7/16". Overall Width, 1 5/16" to 1 5/8". Center Dist. from face of hub: 13/16" to 1 1/4".

For B—5/8" Belts: Pitch Dia. 1 1/2" to 13 1/2". Bore Dia., 1/2" to 1 1/2". Bore Length, 1 1/4" to 1 17/32". Overall Width, 1 13/32" to 1 33/32". Center Dist. from face of hub, 13/16 to 1 1/4".



"CENTRAL" Flexible Couplings

Extreme simplicity of construction cuts assembling costs, eliminates constant adjusting and servicing. Consist of two metal flanges and one non-metallic insert. Available in wide variety of sizes. What are your transmission requirements?

Central Die Casting and Mfg. Co., Inc.
2935 W. 47th STREET • CHICAGO 32, ILL.

Kling
ROTARY SHEARS
DO MANY TYPES OF WORK
DOES ALL THIS WORK FOR YOU
1 CUTS STRAIGHT LINES
2 CUTS RINGS-SMALL OR LARGE RADII
3 CUTS CIRCLES
4 NAMES FLANGES
5 CUTS INSIDE HOLES WITHOUT CUTTING IN FROM EDGES
6 JOGGLES & OFFSETS
7 CUTS OLD SHAPES
8 BEVELS AT ANY ANGLE
9 CUTS REVERSE CURVES
10 BEADS & CURLS
ALL WITH Hairline PRECISION

Yes, and With Hairline Precision

Rapid operation . . . Hairline Accuracy . . . the use of Kling Rotary Shears marks the latest development in cutting mild steel, and sheet metal, up to 1-inch with amazing savings in time, labor, and production costs.

For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.

In metal working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done,—this machine is held in high regard for its versatility and economy of operation.

This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.

Send Today for Bulletin No. 245

which will give you specific facts, and specifications. No obligation involved. Users of heavy equipment of Kling Rotary Shears' class will receive a copy of this Bulletin promptly, on request.

KLING BROS. *Engineering Works*

1322-HV No. Kostner Ave., Chicago 51, Illinois

EXPORT DEPT. 1111 South Ferry Building, New York 4, N. Y.

Water Temperature Control

Condensed Catalog No. 3035 describes a line of regulators and thermostatic water mixing valves made for water temperature control. Thermostatic regulators and valves are shown for: all types of hot water heaters, and 3-way mixing valves for two temperature hot water systems; all types of shower baths, individual, gang and zone showers; hospital hydrotherapy baths; shampoo fixtures; X-ray and photo developing baths; industrial processes and laboratories; steam and water mixers for dishwashers; and various thermostatic water mixing valves used in washing autos, trucks, busses and locomotives.—*The Powers Regulator Co., 2720 Greenview Ave., Chicago 14, Ill.* 248

Fin-Pipe Radiation

Standard fin pipe radiators for heating industrial plants, institutions and commercial buildings are described in a four-page bulletin which includes tables of correction factors for steam and hot water. These steel fin pipes are offered for both heating and refrigeration.—*Standard Heat & Power Co., 470 Main St., Clinton, Mass. Distributed by United States Radiator Corp., Detroit 31, Michigan.* 249

Boiler Water Level Control

Bulletin No. 465, a Copes Performance Report, covers the installation of boiler water level controls at the West Reading Station of Metropolitan Edison Company.—*Northern Equipment Co., Erie, Pa.* 250

Control for Spreader Stokers

Bulletin 1022, 4-pages, gives data on automatic control layouts for spreader stokers and explains function of Bailey Controlled components.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.* 251

APRIL, 1947

TO OBTAIN COPIES OF TRADE LITERATURE listed in this issue, circle on the list below the publications wanted, using the item number at the end of each review.

Print your name and address, mail to
Editor, HEATING AND VENTILATING,
148 Lafayette Street, New York 13, N. Y.

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236	237	238	239	240	241	242
243	244	245	246	247	248	249
250	251					

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EXCLUSIVE GRILLE DESIGN gives POSITIVE "4-WAY" AIR STREAM DIRECTIONAL CONTROL

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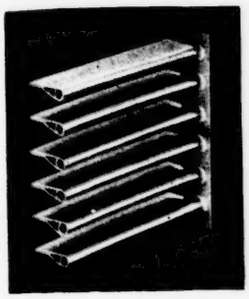

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These great advantages assure complete air stream diffusion from air conditioning outlets.

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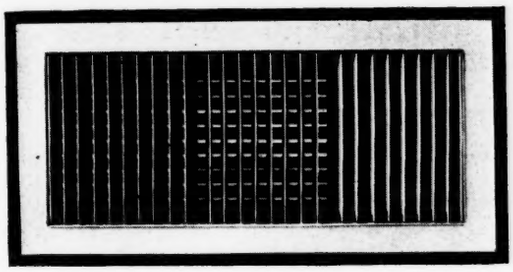

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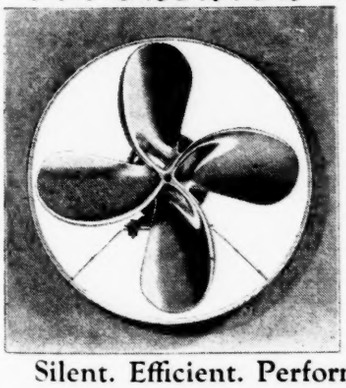

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Many foremost manufacturers, having discovered our specialized skill in our particular line, have entrusted us with a great variety of precision pipe and tube work, including bending, coiling, expanding, flattening, brazing and welding.

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NOT TO WORK

ON THAT!

A squirrel has a hard time making a living. He can't afford to do useless and unprofitable work.

So, he inspects every nut he picks up. If he gets hold of a bad one, he throws it away.

The plumber or steamfitter doesn't have to inspect "K" fittings. Bad ones are thrown away at the factory. This saves the work and grief which would result from misalignment, leaks, call-backs.

Insist on "K" fittings.

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K PRECISION FITTINGS

COMBINED MARKET FACILITIES at Malleable Iron Fittings Co., Branford, Conn., and at Kuhns Bros. Co., Dayton, Ohio.

INDUSTRIAL DEGREE-DAYS
February, 1947

City	55F Base	45F Base
Baltimore, Md.	648	368
Buffalo, N. Y.	656	467
Cleveland, Ohio	906	626
Detroit, Mich.	912	632
Indianapolis, Ind.	868	590
New York, N. Y.	726	446
Philadelphia, Pa.	698	418
Pittsburgh, Pa.	924	644
St. Louis, Mo.	740	465

CANADIAN DEGREE-DAYS FOR FEBRUARY, 1947*

City	February 1947	February Normal	Cumulative, Sept. 1 to Feb. 28 1946-47	Cumulative, Sept. 1 to Feb. 28 Normal
Calgary, Alta.	1428	1355	6940	6666
Charlottetown, P. E. I.	1137	1338	5294	5666
Crescent Valley, B. C.	944	1112	5629	5743
Edmonton, Alta.	1733	1501	7910	7299
Fort William, Ont.	1554	1582	7182	7204
Grande Prairie, Alta.	1742	1456	8339	7456
Halifax, N. S.	1014	1170	4651	5068
London, Ont.	1294	1240	4880	5253
Medicine Hat, Alta.	1523	1406	6925	6438
Moncton, N. B.	1204	1392	5633	6106
Montreal, P. Q.	1447	1460	5780	6108
North Bay, Ont.	1585	1492	6647	6653
Ottawa, Ont.	1495	1459	6056	6382
Penticton, B. C.	896	969	5011	4779
Porquis Junction, Ont.	1686	1764	7513	8064
Prince George, B. C.	1036	1305	6661	6677
Quebec City, P. Q.	1397	1481	6108	6688
Regina, Sask.	1921	1764	8496	8137
St. John, N. B.	1109	1266	5094	5652
Saskatoon, Sask.	1994	1635	8675	7911
Toronto, Ont.	1188	1206	4601	5154
Vancouver, B. C.	683	678	4084	3797
Victoria, B. C.	577	689	3625	3414
Windsor, Ont.	1221	1148	4406	4877
Winnipeg, Man.	831	1775	8003	8091

*These data are supplied through the courtesy of the Meteorological Division, Air Services Branch, Department of Transport, Canada, with the cooperation of N. W. Etter, Heating Engineer, Enamel & Heating Products Limited, Sackville, N. B.

The Department reports a slight revision in the figure for January for Regina, Sask., as published in last month's issue. Corrected figure is 1848.

. . . Since the Last Issue

Start of production of Fiberglas building insulation in its new plant in Kansas City, Kansas, was announced by **Owens-Corning Fiberglas Corp.** Manufacture of this product, nationally distributed by Armstrong Cork Co., The Flintkote Co., and the U. S. Gypsum Co., has been centered heretofore at the Fiberglas plant in Newark, Ohio.

Minneapolis-Honeywell Regulator Co. and its industrial division, **Brown Instrument Co.**, have opened a district office at 27 Halstead Street, East Orange, N. J.

Fairbanks, Morse & Co., Chicago, recently announced the appointment of **John A. Cuneo** as manager of their Los Angeles branch, succeeding Harry W. Brown who has retired.

Frank P. Bleier, industrial physicist and widely known designer of air moving equipment, has established his own consulting offices at 547 W. Addison Street, Chicago, Ill. Mr. Bleier will serve manufacturers whose lines include fans, blowers and compressors of both axial and radial flow types. For the past four years he has been director of research and development of the Ilg Electric Ventilating Co. He is a graduate of the Technical University of Vienna, Austria, in applied mechanics and aerodynamics and has published many technical papers in the field of fan and blower design.

Westinghouse Electric Corp. recently announced the appointment of **C. B. Stainback** as industrial syndicate manager, a new position created to better coordinate the industrial sales activities of the company. Mr. Stainback was promoted to assistant sales manager of the industrial sales department in 1931 and seven years later was named manager of the department. He will be succeeded in that position by **John E. Payne** who has been named headquarters industrial sales manager. Mr. Payne was formerly manager of industrial sales for the central district.

H. Follett Hodgkins, president of Lipe-Rollway Corp., **W. H. G. Murray**, president of Smith-Murray Corp. and **Frederick B. Scott**, president of the Syracuse Supply Co. were elected directors of **Carrier Corp.** at the annual stock-

F. B. Scott

H. F. Hodgkins

W. H. G. Murray

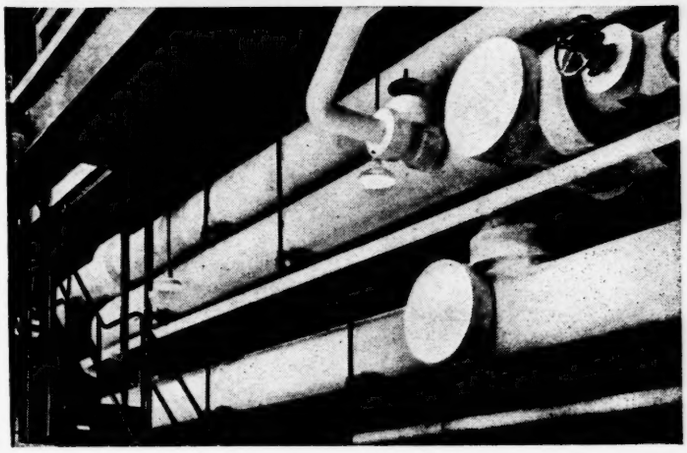
holders meeting in Syracuse. The new members will bring Carrier's board of directors to a total of fourteen, of whom three, Dr. Willis H. Carrier, chairman, Cloud Wampler, president, and Edward T. Murphy, senior vice-president, are officers of the corporation and residents of Syracuse. The other eight members of the board represent a variety of industrial and financial experience.

The Industrial Division of **York-Shipley, Inc.**, York, Pa., announces an expanded sales and service organization. **F. W. Cooper** is assistant manager of the division; **J. Walz, Jr.** is district manager for the middle west; **R. P. Lindemuth** is district manager, middle Atlantic; and **C. M. Keady**, southern district manager. **W. S. Tallon** is application engineer for the division; **E. W. Hagblom** and **B. S. Shewell** are field service engineers.

Three major changes among executive sales personnel of **Frigidaire Division of General Motors Corp.** have been announced. **P. H. Brennan**, commercial sales manager, has been appointed sales manager of the direct factory sales division; **W. F. Switzer**, manager of marketing research, has been appointed manager of commercial sales, replacing Mr. Brennan, and **L. W. Smith**, assistant marketing research manager, has been appointed marketing research manager, succeeding Mr. Switzer.

Assembly line production of Miraculas, the recently announced year-round home air conditioning units, will start September 1, according to the **General Engineering and Manufacturing Co.**, St. Louis. The Miracula is a heat pump which extracts and amplifies heat from the earth.

The easy, practical way to cover insulated surfaces



Sewing the canvas—or applying metal strapping—these time-consuming operations are no longer necessary. The canvas, asbestos, fiberglas or other non-conductor can be securely bonded with Arabol Lagging Adhesive.

This adhesive dries in 4 to 6 hours; *leaves a sized finish on the lagging material* . . . the job is completed. No paint need be used on this sized finish, unless you prefer to add one coat for appearance. Maintenance is simplified—grease, oil, soot and dirt wash off easily. And the adhesive is vermin-proof . . . fire-retardant, too.

Arabol Lagging Adhesive has successfully passed rigorous tests by independent laboratories. The results show that it retains its adhesive powers despite exposure to extreme temperatures, to immersion in water and to live steam.

Write us today for detailed facts and figures. Don't place open specifications on lagging work — ask for Arabol Lagging Adhesive. You can depend on it to fill your most exacting requirements for both utility and appearance. Also, ask about our cork cement for adhering cork to cork on refrigerator lines.

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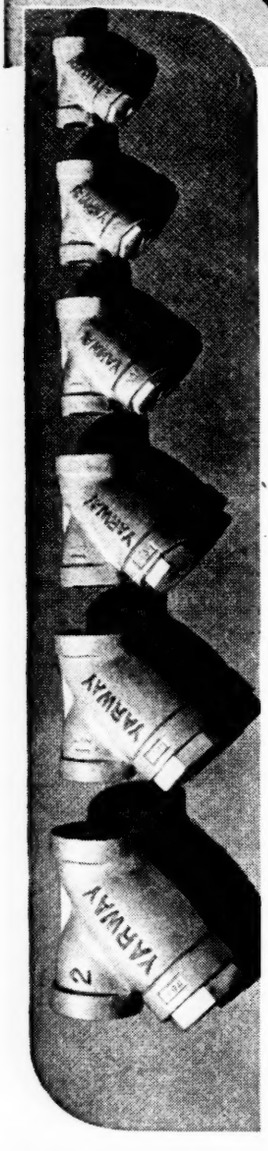

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See Your Supply House or Send for Bulletin S-201

YARNALL-WARING COMPANY
104 MERMAID AVE., PHILADELPHIA 18, PA.

YARWAY STRAINERS

General Controls Co. announces the appointment of **E. B. Maire** as regional sales manager of the mid-western, southern and eastern branch office territories: Boston, New York, Philadelphia, Pittsburgh, Detroit, Cleveland, Atlanta and Chicago.

Bell & Gossett Co., announces the appointment of **Frank C. Hackett** as sales promotion manager. Mr. Hackett has been with the company for thirteen years, in charge of an eastern sales territory. During the war he did an outstanding job in working with various Government agencies. Prior to joining the Bell & Gossett Co., he was associated with the Ames Iron Works, Pierce Butler Radiator Corporation and Construction Code Authority at Washington, D. C. Part of his time will be devoted to conducting the educational program on modern heating now being developed by the Bell & Gossett Co.

F. C. Hackett

H. E. Williams has been promoted to eastern regional sales manager of the heating controls division of the **Minneapolis-Honeywell Regulator Co.** He will make his headquarters at the company's New York City office.

Gerald Earle Otis, vice-president of the **Herman Nelson Corp.** of Moline, Ill., retired on March 31. Mr. Otis, nationally known as an authority on heating and ventilating of schools, will continue as a director of the company. A native of Leipsic, Ohio, Mr. Otis started with Herman Nelson on May 30, 1918 as chief engineer. Prior to that he was heating and ventilating engineer for the city of Buffalo, N. Y.

Perfex Corp., Milwaukee, manufacturer of automatic temperature controls and industrial engine radiators, has announced that **V. Robins Tate,** vice-president and secretary of the firm, was elected executive vice-president at the February meeting of the board of directors. It was also announced that **Hugh Kelly** has been named chief engineer.

Paul B. Sagar has been appointed sales and service education engineer for the **Norman Products Co.,** Columbus heating equipment manufacturing firm. Mr. Sagar was formerly associated with General Controls Co. as field engineer handling sales organization, service education and control application to gas fired appliances east of the Rocky Mountains. He is a member of the A.G.A. Research Advisory Committee for burners, controls and accessories, and has served on many national committees dealing with gas heat engineering. He is a graduate of Oregon State College.

P. B. Sagar

Stok-A-Fire Co., Inc., announces the change of name of the corporation to **Automatic Firing Corp.** Since the beginning of World War II, it has been the aim of the company to produce automatic firing apparatus for all lines of heating. The change of name is the only change in the corporate set-up.

Appointment of **Kenneth L. Walker** as vice-president in charge of production has just been announced by the **Kalamazoo Stove & Furnace Co.**

Edward R. Mangus, 4027 Russell Blvd., St. Louis, has been appointed representative for **Acme Industries, Inc.** in the territory consisting of Missouri, Southern Illinois and the western section of Kentucky. Mr. Mangus was formerly head of the refrigeration section at the David F. Ranken School of Mechanical Trades. **Harold S. Ryan,** 414 Vance Bldg., Seattle, has been appointed Acme representative for Washington, Idaho and Montana. Mr. Ryan was formerly a representative for Drayer Hanson. **J. Harvey Seat & Associates,** manufacturers agents, 161 Simpson St., N. W., Atlanta, is the newly appointed representative of Acme Industries in Tennessee. **Thermal Engineering Co.,** of Atlanta represents Acme in Georgia, South Carolina and northern Florida. For the Iowa and Minnesota territory, **Delavan Engineering Co.,** 414 12th St., Des Moines, has been recently apppointed. **Graham Refrigeration Products Co.,** 1694 Main St., Springfield, Mass., has opened a new office at 5871 Main St., Buffalo, N. Y., and will represent Acme in that area.

Two executive appointments have been announced by **McQuay, Inc.,** Minneapolis manufacturers of air conditioning and refrigeration equipment. **Philip S. Morris** has been named assistant to the president, in charge of purchases, advertising and credit, and **Blake Thomas** has been appointed assistant general sales manager. Mr. Morris' interest in air conditioning equipment began many years ago in the food business when he was vice-president of the J. N. Collins Co., of Minneapolis and Philadelphia, at that time the largest manufacturer of caramels in the

P. S. Morris

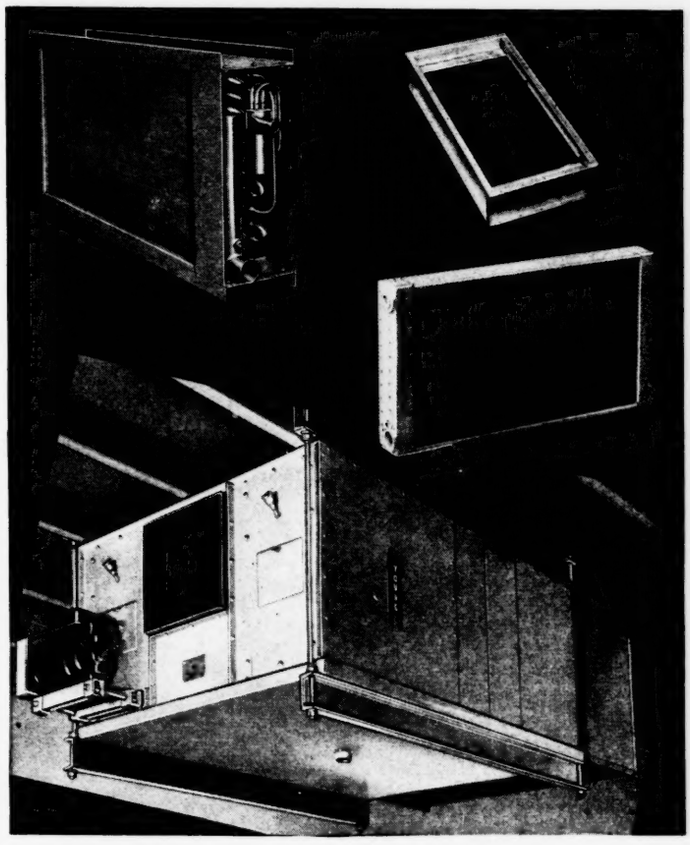
B. Thomas

United States. Before joining McQuay, Inc., he was executive vice-president and general manager of the McQuay Aircraft Corporation and of the Plxweve (correct) Manufacturing Co., both of Los Angeles, California. English-born Mr. Thomas has returned to the United States after an extensive period abroad. The war caught him in London, where he was general sales manager of the Chronomatic Corp., manufacturers of time control equipment. Before joining the Chronomatic Corp., Mr. Thomas had been architectural and engineering representative of the American Radiator Corp., district sales manager for McQuay Radiator Corp., and western sales manager for the Erskine Copper Radiator Corp.

Plans to expand manufacturing facilities at the **Westinghouse Electric Corp.'s** Buffalo, New York, plant have been announced. The new operation, formerly a part of the Switchgear and Control Division at East Pittsburgh, will be known as the Industrial Control Division. To facilitate the transfer, **L. R. Ludwig,** manager of the Motor Division, has been assigned responsibility for this operation in its present location. Operations at Buffalo will eventually include motor, industrial control, copper wire and welding activities, and will be known as the Buffalo Divisions, rather than the Buffalo Motor Division. Mr. Ludwig will be manager of the Buffalo Divisions. About 75,000 sq ft of additional floor space will be added to the Buffalo plant, bringing the total floor space available for manufacturing to 1,700,000 sq ft.

STANDARDIZE ON YOUNG

HEATING-COOLING COILS
and
AIR CONDITIONING UNITS



Heat transfer equipment for heating, cooling and air conditioning systems are "catalog" items with Young. Through a continuous program of engineering and modern manufacturing techniques Young offers advanced designs—high efficiency operation.

Young coils are available in six types: for hot water and steam heating; for water or refrigerant cooling. "Streamaire" Air Conditioning Units are simple to install and take little space. They complete the functions of heating, cooling, cleaning and humidifying, or dehumidifying. It is possible to specify a "Streamaire" Unit to perform one or any combination of these services.

Write today for complete information on Young Heating and Cooling Equipment.

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INTERCOOLERS • EVAPORATIVE COOLERS ENGINE JACKET WATER COOLERS
GAS COOLERS • UNIT HEATERS CONVECTORS • CONDENSERS • AIR
CONDITIONING UNITS • EVAPORATORS HEATING COILS • COOLING COILS
AND A COMPLETE LINE OF AIRCRAFT HEAT TRANSFER EQUIPMENT

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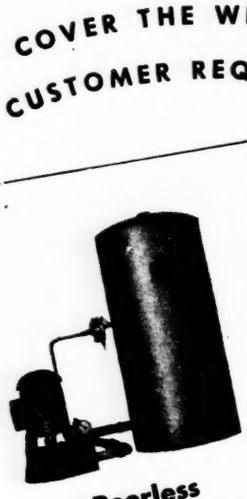
Sales and Engineering Offices in All Principal Cities

Peerless Dealers sell these 2 most advanced *Domestic Water Systems*

THAT COVER THE WIDEST RANGE OF CUSTOMER REQUIREMENTS



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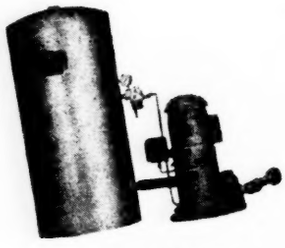
Peerless Advanced Jet System

For deep or shallow wells. Capacities: 400 to 5000 gals. per hour. For moderate water supply requirements. Easily installed. Economical to operate.



Peerless Water King

For shallow wells. Capacities: 275 to 860 gals. per hour. Utilizes magic water lift principle. Completely automatic. Compact. Self-contained. Efficient. Economical. Streamline Design.

A few Peerless features that give you More to Tell—More to Sell

Advanced designs — Supersimplicity of operation — More gallonage at lower cost — Larger, more uniform flow over entire pumping range — Smooth, quiet operation.

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If you are planning to complement your present business with a line of domestic water systems, FULLY INVESTIGATE the many added features offered to Peerless Dealers. For increased profits and added advantages of pump construction and operation, Plan With Peerless in 1947. Write for full details now.

PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: **Canton 6, Ohio; Quincy, Illinois; Los Angeles 31, California**

District Offices: **Canton 2, O.; Ardmore, Pa.; Decatur, Ga.; Dallas 1**

Distributors in Principal Cities

Derbyshire Machine & Tool Co., announces the availability of its Fluid Flow Laboratory for testing, developing, and original research on fluid flow devices and flow engineering problems. Fully equipped with steam, air, and water facilities, the laboratory is also adaptable for the handling of many other fluids. In conjunction with the laboratory, complete experimental shop facilities are available for the fabrication of special parts and complete working models. All activities are under the direction of **A. E. Reinhardt,** former staff member at M. I. T., who is assisted by experienced technicians.

Appointment of **John F. Chester** as director of public relations of **Carrier Corp.**, has been announced. Mr. Chester has been general business editor of the Associated Press in New York since 1945, when he returned to this country after two years as correspondent in the Near East, Italy and France. For a period of months he was chief of bureau at Cairo and was in charge of coverage at the Cairo and Tehran conferences. From 1936 to 1943, Mr. Chester was chief of the Associated Press Boston bureau, following seven years in Washington in a variety of journalistic capacities, including White House correspondent.

J. F. Chester

At the 30th annual meeting of the **National Association of Fan Manufacturers** held at Gulfport, Mississippi, the following officers were elected for the ensuing year: **T. J. Flanagan,** president; **G. C. Derry,** vice-president; and **L. O. Monroe,** secretary-treasurer. Mr. Flanagan is president of Garden City Fan Co., Chicago, Illinois and Mr. Derry is vice-president and general manager of B. F. Sturtevant Co., Boston, Massachusetts.

Purchase of a 42-acre plant site in Santa Clara, California, and plans to erect a 500,000 sq ft Fiberglas factory there to supply western markets, were announced by **Owens-Corning Fiberglas Corp.** The site is in the Pasetta industrial tract at the intersection of Kifer Road and the Santa Clara-Alviso Road. It is in the bay area about 40 miles south of San Francisco.

Young Radiator Co., producer of heat transfer products at Racine, Wis., announces the appointment of **Theodore C. Rademacher, Jr.** as advertising and sales promotion manager. Mr. Rademacher, a native of Racine, was formerly assistant merchandising manager of the Massey-Harris Company, farm machinery manufacturers of that city. Prior to that he was engaged in advertising and display work for two other Racine concerns. He is 33 years old, married, and is at present holding the office of secretary of the Advertising Club of Racine.

T. C. Rademacher, Jr.

Minneapolis-Honeywell Regulator Co. has formed a new sales division to market its warm air registers and grilles. **L. J. Krause** is directing the activities of this division. For the past year, he has been supervising field surveys and preparation of literature for the new registers and will direct sales of the products when production is in full swing. Limited production of the new units has been started in Honeywell's Wabash plant. Distribution and sales will be handled through the company's branch offices.

George F. Naumann has been appointed manager of the Edwardsville, Ill., plant of the **United States Radiator Corp.** His appointment follows 31 years of service to the company.

Air Devices, Inc., recently announced the appointment of **Irving M. Day,** as Washington, D. C. representative for their entire line of air filters, diffusers and exhausters. Mr. Day's headquarters will be located at 718 Mills Building.

Oscar R. Tolerton, as Youngstown, Ohio representative whose headquarters will be at 1837 Selma Ave., and **R. E. Gardner** as Nashville, Tenn. representative who will be located at Richmond Drive.

At the 21st annual meeting of the **Industrial Unit Heater Association** held at New Orleans, the following officers were elected for the ensuing year: **R. H. Nelson,** president; **R. J. Resch,** vice-president; and **L. O. Monroe,** secretary-treasurer. Mr. Nelson is president of **The Herman Nelson Corp.,** Moline, Ill. and Mr. Resch is president of **McQuay, Inc.,** Minneapolis, Minn.

Getting Personal

F. G. Hechler (co-author, *Heat and Moisture Transfer in All-Metal Houses*, page 69) has been introduced already to H&V readers in connection with his article, *The Climatometer. An All-Weather Room*, which appeared in the September, 1945, issue.

E. R. Queer

E. R. Queer (co-author, *Heat and Moisture Transfer in All-Metal Houses*, page 69) was born May 26, 1904 at Johnstown, Pennsylvania. He attended secondary schools in Johnstown and completed his M.S. in Electrical Engineering at The Pennsylvania State College in 1928. He continued at the college as instructor of engineering research through 1934, during which period he engaged in thermal research on building and insulating materials. He became assistant professor of engineering research as well as conducting heat transmission tests on naval warship constructions for the U. S. Navy through 1941. He was called to active duty in the U. S. Navy and after a tour of duty at sea in connection with ventilation, air conditioning and habitability of warships, returned to the Bureau of Ships as executive officer to the officer in charge of the air conditioning section in May, 1942. He was placed in charge of the development of dehumidification techniques for the preservation of the Inactive Fleets in the post-war Navy. He also assisted the Bureau of Supplies and Accounts in development of a test program for the preservation of material in warehouses using dehumidification. He received commendations from Admiral Nimitz for work in the fleet early in the war and from the Secretary of the Navy for work in the Bureau of Ships. He was discharged from active duty with the rank of Commander in August, 1946 and returned to the Pennsylvania State College Engineering Experiment Station with the rank of professor of engineering research. There he was placed in charge of the Thermal Research Laboratory. In this capacity he is supervising research in chemical dessicant dehumidifiers, heat transmission, and moisture transmission in prefabricated houses. He has established a consulting engineering partnership with E. R. McLaughlin.

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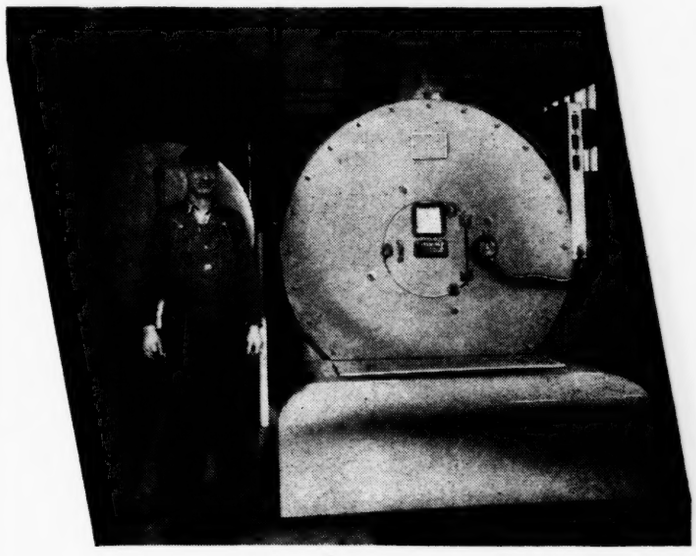
precision combustion



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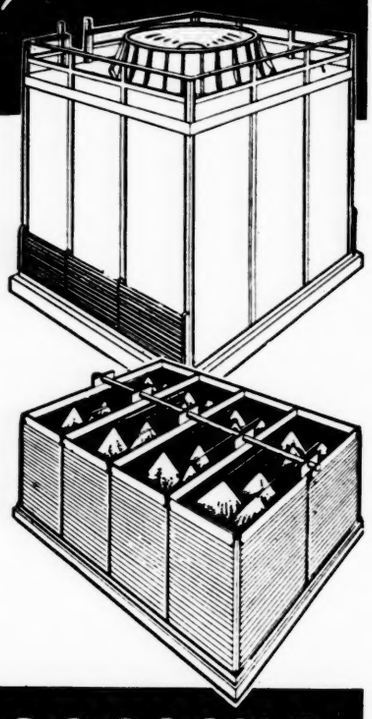

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3/8	3/16	5/8	1/4
1/2	3/32	5/8	5/16
1/2	1/8	3/4	1/8
1/2	5/32	3/4	3/16
1/2	3/16	3/4	1/4
1/2	1/4	1	1/8
9/16	1/4	1	3/16
		1	1/4

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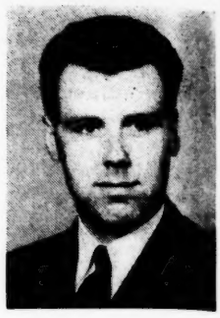

E. R. McLaughlin

Everett R. McLaughlin (co-author, *Heat and Moisture Transfer in All-Metal Houses*, page 69) assistant professor of engineering research at the Engineering Experiment Station of The Pennsylvania State College, was born March 28, 1918 at Leechburg, Pennsylvania. He received his M.S. degree in mechanical engineering in 1941 from The Pennsylvania State College, having joined the faculty there as graduate assistant in 1939. He was transferred to the Engineering Experiment Station as research assistant in 1940; appointed as instructor in engineering research in 1941; and became assistant professor of engineering research in 1945. His duties have included testing building insulating materials, insulated deck sections, and infra-red reflective paints exposed to solar radiation. He is currently engaged in testing and rating dynamic dehumidification equipment for the U. S. Navy and in conducting studies on conventional and prefabricated house structures for the National Housing Agency. He is a registered professional engineer in Pennsylvania.

W. T. Anderson, Jr.

William Theodore Anderson, Jr., (*Ultraviolet Sanitary Ventilation*, page 63), was born in Trenton, N. J., on January 2, 1899. His ancestors were of Netherland and Scottish origin, having migrated to the North American continent with the original settlers of New Amsterdam (one of them is reputed to have traded what is now Times Square for a herd of goats). His formal education was comp'eted at Trenton High School 1916; Princeton University 1921, B. S.; Princeton University 1923, Ph. D. He had leave from Princeton University for three years to serve with the Army in World War I. He had leave from Hanovia Chemical & Mfg. Co. for three years to serve in the U. S. Navy, World War II, as Lieutenant Commander USNR, naval physicist in radiation. He has been director of research, Hanovia Chemical & Mfg. Co., Newark, N. J., in researches on ultraviolet radiations.

Dr. Anderson has 46 patents on inventions in the ultraviolet field, and has had many articles published in scientific, technical and medical journals. Many of his researches have been in cooperation with others in universities, hospitals, dairies, farms, schools, and other manufacturing companies. He is interested in many scientific societies including the following in which he is a member, Princeton Engineering Association, American Chemical Society, Optical Society of America, Congress of Physical Medicine, American Society of Heating and Ventilating Engineers, Illuminating Engineering Society.

Leo T. Parker, author of this month's reference section (*Law of Contracts Simplified*, page 83) has both a legal and an engineering background. He has, therefore, the technical approach in considering legal contract problems of the heating and ventilating engineer.

From 1915-17 he manufactured automobile accessories in Cincinnati. For the next two years he served as a Lieutenant of Infantry. In 1921 he was admitted to the Ohio Bar and also completed a course in mechanical engineering and machine design. The following year Mr. Parker was admitted to practice before Federal Courts and to practice patent law before the U. S. Patent Office. Since then he has practiced law in Cincinnati and has written legal articles for a large number of technical magazines.

Mr. Parker has erected several apartment house buildings in Cincinnati.

This reference section is to be followed by other articles by Mr. Parker that will present legal information of value to the heating and ventilating engineer.

COMING EVENTS

MAY 8-9, 1947 — Fifth Annual Anthracite Conference of Lehigh University, at Bethlehem, Pa. E. H. Walker, Chairman, Committee on Publicity, Anthracite Institute, 101 Park Ave., New York 17, N. Y.

JUNE 2-4, 1947—Semi-annual meeting of the American Society of Heating and Ventilating Engineers, Hotel del Coronado, Coronado, Calif. A. V. Hutchinson, secretary of the Society, 51 Madison Ave., New York 10, N. Y.

JUNE 8-11, 1947—34th Spring meeting of the American Society of Refrigerating Engineers, Hotel Alexandria, Los Angeles, Calif. M. C. Turpin, acting secretary of the Society, 40 W. 40th St., New York 18, N. Y.

JUNE 11-14, 1947—58th Annual meeting, Heating, Piping and Air Conditioning Contractors National Association, Netherland Plaza Hotel, Cincinnati, Ohio. Joseph C. Fitts, secretary of the Association, 1250 Ave. of the Americas, New York 20, N. Y.

JUNE 16-19, 1947—Semi-annual meeting of The American Society of Mechanical Engineers, Stevens Hotel, Chicago, Ill. Ernest Hartford, executive assistant secretary, 29 W. 39th St., New York, N. Y.

JUNE 24-27, 1947—38th Annual meeting of the National District Heating Association, The Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. Further details from the Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.

SEPT. 1-4, 1947—Fall meeting of The American Society of Mechanical Engineers, Hotel Utah, Salt Lake City, Utah. Ernest Hartford, executive assistant secretary, 29 W. 39th St., New York, N. Y.

DEC. 1-5, 1947—Annual meeting of The American Society of Mechanical Engineers, The Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. Ernest Hartford, executive assistant secretary, 29 W. 39th St., New York, N. Y.

DECEMBER 8-10, 1947 — Annual convention, American Society of Refrigerating Engineers, Hotel Traymore, Atlantic City, N. J. Acting secretary, M. C. Turpin, 40 W. 40th St., New York 18, N. Y.

JANUARY 26-29, 1948—Fifth All-Industry Exposition of the Refrigeration Equipment Manufacturers Association, at Cleveland Public Auditorium, Cleveland, Ohio.

FEBRUARY 1-4, 1948—54th Annual meeting, American Society of Heating and Ventilating Engineers, to be held in New York in conjunction with the 8th International Heating and Ventilating Exposition. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York, N. Y.

JUNE 9-11, 1948 — Spring meeting, American Society of Refrigerating Engineers, New Ocean House, Swampscott, Mass. Act'ng secretary, M. C. Turpin, 40 W. 40th St., New York 18, N. Y.

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